BEGINNING TEACHERS' TECHNOLOGY INTEGRATION SELF-EFFICACY BASED ON LEVEL OF TECHNOLOGY INFUSION IN THE UNDERGRADUATE PROGRAM

by

Reeshemah Tamar Johnson

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

Four-year educator preparation programs in North Carolina are tasked with producing teachers capable of effectively integrating technology in the curriculum. The state created The Digital Learning Competencies for Classroom Teachers as the guidelines for what teachers are expected to know and be able to do with regards to digital technology integration. The purpose of this study was to determine if a relationship existed between beginning teacher self-efficacy with technology integration and the extent to which technology was infused in their undergraduate four-year educator preparation programs (stand-alone course versus technology infusion across the undergraduate curriculum versus a combination of both a technology course and technology infusion). This study used a non-experimental ex post facto causal-comparative design to examine the survey responses of 126 elementary school teachers in North Carolina who graduated from four-year educator preparation programs and were in the first three years of their teaching careers. The scale used was an electronic version of the Technology and Teaching Efficacy Scale (TTES). The data was analyzed using a one-way analysis of variance (ANOVA) in SPSS. The study did not identify any statistically significant differences in the beginning teachers' total technology integration self-efficacy scores based on the level of technology infusion in their undergraduate teacher education programs. Recommendations for further research include replicating the study across the state, follow-up qualitative research, and longitudinal research on beginning teacher technology integration self-efficacy over the first three years.

Keywords - educational technology, pre-service teacher, beginning teacher, technology integration, technology integration self-efficacy, dedicated technology course, technology infusion.

Dedication

I must acknowledge my husband, Andrew, who had to endure six years of only partially having a wife. I know that it was a difficult period for you, but although the going was tough, we persevered. Now we can look forward to enjoying our future together.

My darling children, I love you all so much. Reshon, you would often look after your brother and sister so I could work without interruption. I hope you understand how much such a small gesture meant to me. I hope that I am an example for you as you now embark on your own collegiate educational journey. I hope that you will follow in my footsteps and maximize the educational potential that I see in you. Arianna, you have become such an independent young lady, and I know much of that growth was to take some of the pressure of taking care of you off me. I love you for that, and I pray that sweet spirit of yours continues to grow and shine. Nicholas, you tried so hard to be understanding when I could not spend time with you because I had to do my work. You would bring me water when I looked thirsty and cover me with a blanket when I fell asleep on the couch. You were my little stress ball as just one hug from you gave me the strength I needed to keep going.

Mommy, Beverley, and Yasmin, you would not blink an eye when I said I needed you to keep the kids so I could have some peace and quiet, even at ridiculously short notice. Sometimes you volunteered to keep them as a way of encouraging me to work. I appreciate it more than you would ever know.

Even with the support that my family provided, I would not have made it through this journey without the grace of God. There were times that I wanted to quit, but He reminded me that not my will, but His will would be done. I know that God has a plan for me, and I know that this is but one piece of that plan. I dedicate this manuscript to my family, who supported me throughout my studies and to my God, who, with much prayer, carried me through the process.

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List of Abbreviations

Council for the Accreditation of Educator Preparation (CAEP)

Educator Preparator Program (EPP)

House Bill (HB)

Information and Communication Technologies (ICT)

Institutional Review Board (IRB)

Institutions of Higher Education (IHEs)

International Society for Technology in Education (ISTE)

Interstate Teacher Assessment and Support Consortium (InTASC)

National Council for Accreditation of Teacher Education (NCATE)

National Education Technology Standards for Students (NETS-S)

National Education Technology Standards for Teachers (NETS-T)

North Carolina Department of Public Instruction (NCDPI)

One-way Between-subjects Analysis of Variance (ANOVA)

Public Broadcasting Service (PBS)

Senate Bill (SB)

State Board of Education (SBE)

Teacher Accreditation Council (TEAC)

Technological Pedagogical and Content Knowledge (TPACK)

Technology and Teaching Efficacy Scale (TTES)

Technology Integration Matrix (TIM)

Universal Design for Learning (UDL)

CHAPTER ONE: INTRODUCTION

Overview

The future of schools of education in North Carolina (especially public schools of education) may very well be in jeopardy. North Carolina's legislature is actively seeking alternatives to teacher preparation and licensure (which has traditionally been the responsibility of four-year institutions) and has proposed measures that would allow private entities or corporations to enter the field of teacher preparation (Ball, 2017). Schools of Education in North Carolina will have to justify their existence if they are to stay in operation, and to do so, they should work to improve the preparation of their pre-service teacher education candidates. This study will focus on one area of improving teacher education: preparing candidates to integrate educational technology effectively in the classroom. In this section, there will be a discussion of the background of the study, and an introduction to the problem, purpose statement, significance of the study, research questions, and definitions of relevant terms.

Background

Within the past four years, North Carolina's legislature advanced two bills aimed at increasing the number of teachers entering the workforce and improving teacher effectiveness. One major area of emphasis is improving the ability of beginning teachers to integrate technology in their classrooms. The bills could have serious negative implications for educator preparation programs at North Carolina institutions of higher education (IHEs), at a time when those programs are already facing steep declines in enrollment (Sawchuk, 2015). The first bill, Senate Bill (SB) 599, was a proposal to expand educator preparation programs within the state, essentially allowing agencies not previously designated as educator preparator programs to achieve that designation. Educator preparation programs would need to be approved by the State

Board of Education (SBE), and meet the criteria outlined in SB 599, but the bill did not establish any criteria for the type of organizations that could apply for status as educator preparation programs. The second bill, House Bill (HB) 634, specifically directed the BOE to allow North Carolina's community colleges and private two-year institutions to create lateral entry educator preparation programs.

The implication of both bills is that while lateral entry and other alternative means of licensure are valuable tools for increasing the number of teachers in the state, a much higher number of individuals would be able to obtain teaching licensure without having earned a teaching degree from a four-year college or university (North Carolina School Boards Association, 2017). With the legislature widening the scope of what constitutes an educator preparation program and opening educator preparation to community colleges, for-profit providers, and out-of-state providers, schools of education within the public University of North Carolina system will have to compete for the shrinking pool of students who plan to enter the teaching profession.

Other states such as Florida, Nevada, and Utah previously went the route of implementing initiatives that allowed community colleges to offer baccalaureate and post-baccalaureate licensure programs. Traditionally, community colleges have played an important role in teacher education. Community colleges and universities have nurtured partnerships geared at strengthening transfer and articulation agreements to provide a seamless transfer experience from the two-year to the four-year institution (Bragg, 2017). However, Florida, Nevada, and Utah found it necessary to allow community colleges to offer teacher licensure programs because they faced a dire shortage of teachers.

Despite other measures such as alternative licensure and special certifications that were attempts at curbing the shortage, the number of newly licensed teachers in each state continued to decline each year. Some states such as Utah and Nevada saw no increase in the rate of newly licensed teachers, probably because there were only a few community colleges that were offering baccalaureate and post-baccalaureate licensure. In Florida, the state with the largest number of community colleges offering teacher education baccalaureate programs, there has been an increase in the number of new teachers since the inception of the initiative in 2001 (Park et al., 2016).

The model that North Carolina's legislature is developing closely resembles the model that is in effect in Florida. An overview of the Florida Department of Education's website shows that prospective teachers who already have a non-teaching undergraduate degree have the option of becoming licensed through Educator Preparation Institutes (EPIs), wording that is almost identical to North Carolina's use of the term Educator Preparation Programs (EPPs). In Florida, as in North Carolina, potential sources of licensure are listed as colleges, universities, or private institutions of higher education (Florida Department of State, 2015). The idea of allowing community colleges to offer baccalaureate programs is not without its critics. One argument is that offering baccalaureate degrees is beyond the scope of the mission of community colleges (Daun-Barnett & Escalante, 2014). There may be some basis to the argument, as Park et al. (2016) found that some of the community colleges that began offering baccalaureate degrees have since evolved into four-year institutions, which calls into question whether community colleges can adequately prepare teachers for the classroom. The concerns regarding community colleges as educator preparation providers are relevant to the state of North Carolina since the concern that the North Carolina legislature has is that the state's four-year educator preparation providers need to better prepare teachers to be effective in the classroom, and community colleges are being viewed as viable options.

Although the North Carolina legislature is broadly concerned about beginning teacher effectiveness in the classroom, it is more narrowly focused on beginning teachers' ability to integrate educational technology. Teachers consistently indicate that they do not feel that their educator preparation programs adequately prepare them to use the technologies that they see in the classroom (Becuwe et al., 2017; Instefjord & Munthe, 2016). The North Carolina legislature, therefore, asked the State Board of Education (BOE) to identify alternative methods of training post-service teachers in the use of educational technology to ensure that teachers use technology to provide a digital-age education for all students. In response to the legislature's mandate, the Friday Institute at North Carolina State University was contracted to develop the state's Digital Learning Plan. Within the plan, there is a recommendation to hire contractors to provide training in technology integration to in-service teachers (Friday Institute for Educational Innovation, 2015).

Given the legislature's interest in expanding alternative licensure and its focus on educational technology and digital education, educator preparation programs in North Carolina are expected to prepare their students to integrate technology in their classrooms effectively. Every institution of higher education (IHE) in the state with an educator preparation program is required to submit an IHE Performance Report in which they outline what they are doing to address the priorities established by the State Board of Education (SBE). Educator preparation programs are obligated to report on their current and future efforts to prepare pre-service teachers to integrate digital and other instructional technologies in the teaching and learning environment. Within the IHE report, educator preparation programs typically outline the structure of their candidates' technology integration preparation (North Carolina Department of Public Instruction, 2016). The issue is that when teachers are surveyed about their self-efficacy regarding integrating educational technology, over two-thirds indicate that the most significant barrier to integrating educational technology in their teaching is a lack of training (U.S. Department of Education, 2017).

Grounded in Albert Bandura's social learning theory, self-efficacy refers to the level of confidence that people have in their own ability to perform a task or achieve an objective (Moriarty, 2014). There are conflicting research studies regarding the correlation between teacher self-efficacy and technology use, but the consensus is generally that teachers with higher levels of technology integration self-efficacy are more likely to integrate technology in their teaching and learning activities (Savage, 2016). With the ever-evolving nature of technology, the conversation no longer surrounds whether technology should be integrated in the classroom. Instead, the discussion now concerns how technology will be incorporated into teaching and learning to create students who are prepared to enter a digital and global society, and how teachers and administrators will be prepared to develop and nurture an environment that produces digital and global citizens (McKnight, O'Malley, Ruzic, Horsley, Franey, & Bassett, 2016). This study will focus on the undergraduate preparation of teacher education candidates for technology integration in their future classrooms, and particularly on if the structure of the undergraduate technology integration preparation affects teacher technology integration self-efficacy.

Problem Statement

Three factors that are important in determining if pre-service teachers intend to integrate technology in their classrooms and the extent to which they plan to do so, are technology self-efficacy, attitude towards technology, and perceived ease of use of technology (Li, Li, & Franklin, 2016). This study will focus on technology self-efficacy, which has been proven to have a direct influence on teachers' decisions regarding integrating technology within the teaching and learning environment. Although there has been substantial research conducted on the factors that affect teacher self-efficacy regarding integrating technology, there are fewer research studies available on how each of those factors individually influences teacher technology integration self-efficacy. Factors that affect teacher technology integration self-efficacy include the level of preparation in the educator preparation program, professional development opportunities available, and attitudes towards technology (Hur, Shannon, & Wolf, 2016; Tondeur, Roblin, Braak, Voogt, and Prestridge, 2017). Of these factors, the level of preparation that pre-service teachers receive is considered the most significant factor in determining how effectively teachers integrate new technologies in the classroom (Sadaf, Newby, & Ertmer, 2016).

According to Lemon and Garvis (2016), it is difficult to change teachers' attitudes and beliefs towards technology integration after their beginning years in the teaching profession, and as such, educator preparation programs should purposefully target those beliefs during the pre-service years. During the preservice years, teaching self-efficacy, in general, has been shown to increase linearly throughout the undergraduate program. The trend appears to be slightly different for technology integration self-efficacy, as pre-service teachers are reporting that they do not feel adequately prepared to use the technologies that they will encounter in the classroom (Eyvind & Christophersen, 2017; Matoti, Junqueira, & Odora, 2013). The problem is that teachers are not confident in their ability to integrate technology into the curriculum. Teachers should leave their educator preparation programs having had a comprehensive experience with the educational technology that they will use in the classroom. Educator preparation programs need to know how to structure their programs to provide the best learning experience for their students and ensure that graduates enter the classroom confident in their ability to integrate technology effectively. There are few, if any, studies that investigate how the structure of the undergraduate program affects a teacher's self-efficacy with technology integration.

Purpose Statement

The purpose of this quantitative causal-comparative study will be to test the theory of self-efficacy that relates the technology integration self-efficacy of beginning teachers in North Carolina to the level of technology infusion in their undergraduate program. The independent variable, level of technology infusion in the undergraduate program, will be generally defined as the extent to which teachers had the opportunity to interact with technology throughout the undergraduate program (either a dedicated technology course, technology infused throughout the program, or a dedicated technology course and technology infused throughout the program). The dependent variable, teachers' technology integration self-efficacy, will be generally defined as the level of confidence that teachers have in their ability to integrate technology effectively in their teaching. The study will focus on beginning teachers in their first three years as licensed classroom teachers to reduce the possibility of outside influences on self-efficacy.

Significance of the Study

A primary question in the debate about North Carolina's push to create more opportunities for licensure outside of traditional four-year universities is whether the stakeholders will benefit from such policy. It is yet to be determined if the policy of allowing non-traditional educator preparation programs to offer educator licensure programs will increase the rate of new teachers entering the market, and if those teachers will be adequately prepared for the classroom (Park et al., 2016). North Carolina can look to states such as Florida, Nevada, and Utah to see if those states experienced the desired outcomes. The state's public institutions of higher learning are expected to demonstrate that they can meet the demand for new teachers, and that they are preparing teachers who will be effective in the classroom. Technology is becoming increasingly important in today's society, and teachers are expected to be able to use current and emerging educational technologies in the classroom (Martin, 2015). Beginning teachers are more likely to integrate technology in the curriculum if they feel comfortable with the technology and have confidence in their ability to incorporate those technologies in their teaching and learning activities (Han, Shin, & Ko, 2017). Educator preparation programs should provide educational experiences that prepare pre-service teachers to be competent in integrating current and future educational technologies.

One specific area that research studies have identified as a factor influencing teacher technology integration self-efficacy is educator preparation programs and their effectiveness in preparing teachers to use educational technology in the classroom. Both pre-service and in-service teachers indicate that they would have felt better prepared to integrate educational technology if their teacher education experience had provided an immersive technological experience (Oliver & Townsend, 2013). A gap exists in the research in terms of the effect, if any, that the structure of that educator preparator programs' technology integration instruction has on preservice teacher self-efficacy. The results of this study will contribute to the scholarly literature on the relationship between teachers' self-efficacy and their performance in the classroom and may be used to help inform the decision-making process that educator preparation programs use to determine how they prepare their teacher education candidates to integrate technology. This study will specifically examine if the method that an institution uses to prepare its teaching candidates to use technology in the classroom affects those candidates' self-efficacy with educational technology. Schools of Education in North Carolina would benefit from determining best practices for training teacher candidates to integrate technology and digital applications in the classroom. Otherwise, the state legislature might find it best to pursue the option of expanding educator preparation in the state, pursue alternate methods of licensure, and hire contractors to provide educational technology professional development for in-service teachers.

Research Question

RQ1: Is there a difference in technology integration self-efficacy scores among beginning elementary school teachers by level of technology infusion in the undergraduate educator preparation program (dedicated technology course, technology infusion, or dedicated technology course plus technology infusion)?

Definitions

1. *Educational technology* – technological resources, processes, and procedures geared at improving teaching and learning in the classroom. Includes elements such as instruction, instructional resources, productivity tools, digital applications, assessment tools, and student management systems (Lakhana, 2014).
2. *Pre-service teacher* – student enrolled in an educator preparation program at a four-year institution of higher education (Bullock, 2013).
3. *Beginning teacher* – fully licensed teachers who are in their first three years of teaching in the classroom (Tondeur, Roblin, Braak, Voogt, and Prestridge, 2017).
4. *Technology integration* - using technological devices or processes to support, provide instruction for, or assess student learning (Harris, 2016).

5. *Technology integration self-efficacy* – to the level of confidence teachers have in their ability to integrate technology in their classrooms in a meaningful way (Hur et al., 2016).
6. *Dedicated technology course* – a single course in an educator preparation program aimed at providing pre-service teachers with basic computer competency skills and introductory knowledge of educational technology (Admiraal et al., 2017).
7. *Technology infusion* – the intentional modeling of the use of technology by teacher education faculty in methods courses throughout an educator preparation program (Tondeur, Roblin, Braak, Voogt, and Prestridge, 2017).

The landscape of educator preparation is changing in North Carolina. The legislature is taking an active role in ensuring that teachers are prepared to integrate digital technology in the classroom effectively, and are actively exploring options for accomplishing this, looking beyond traditional four-year educator preparation programs in the state. It is essential that public educator preparation programs in the state work to ensure that their graduates are entering the classroom confident in their ability to integrate technology. The next chapter will lay the foundation for the framework of the study and present a synthesis of current literature on teacher technology integration self-efficacy. The chapter will also examine the pedagogical application of digital media by subject area and provide examples of digital tools that studies have found to support those educational applications.

CHAPTER TWO: LITERATURE REVIEW

Overview

The nature of today's society makes it imperative that students enter the workforce prepared to operate effectively in an increasingly technological and digital world (Harris, 2016). Today's students are constantly connected. They are hypercommunicators, goal-oriented, and multi-taskers who operate in an increasingly digital world. As such, teachers should enter the classroom possessing the ability to meet students in their digital space. Teachers should possess the skills necessary to engage digital learners and to motivate digital students to become active learners through the use of technological tools and processes (McKnight, et al., 2016). It is the role of educator preparation programs to prepare future teachers to integrate and model the use of technology in the classroom. However, new teachers often do not feel that their educator preparation programs adequately prepared them for that task, and they find that technology is used more in schools than in their educator preparation programs (Instefjord & Munthe, 2016).

This literature review will establish the theoretical framework on which the study will be based. It will broadly examine the characteristics of today's students, and why teachers should integrate technology within the teaching and learning environment. Federal efforts to promote technology integration, barriers to technology integration, and the importance of teachers integrating technology will be examined considering the history of technology integration in schools. Pedagogical applications of digital media will be presented by subject area, as well as examples of how digital media may be used for assessment purposes. The role of the teacher in preparing students for a technological society, and the role of educator preparation programs in ensuring that pre-service teachers develop the skills and confidence necessary for integrating technology in their future classrooms will also be explored.

Theoretical Framework

In 1997, Albert Bandura proposed that it is through continuous interaction with their social environment that human beings develop their ways of thinking and behaving. People learn how to behave based on their experiences and how they observe others behaving in their social environment. The four elements underlying Bandura's theory of social learning are attentional processes, retentional processes, motor reproduction process, and motivational processes (Carroll, Diaz, Meiklejohn, Newcomb, & Adkins, 2013).

Students are more likely to pay attention to behavior that is being modeled if they find the role model attractive, successful, interesting, or popular, or if it is likely that they will have to exhibit the behavior in public (attentional processes). It is therefore important that teachers immediately and repeatedly give students the chance to practice the modeled behavior so that they may retain the behavior. Given the opportunity to practice the desired behavior (retentional processes), students will decide if they wish to continue to demonstrate that behavior, and the degree to which they plan to do so. The decision regarding whether to continue with a behavior is also dependent on the level of the students' motivation since people are more likely to repeat behaviors that elicit positive results or responses (motivational processes). Students often base their decision on their level of self-efficacy with performing the behavior. Whether students continue to exhibit a behavior is dependent on how confident they feel in executing the behavior (motor reproduction processes).

Self-efficacy refers to one's level of comfort and confidence in performing a task. The higher a person's self-efficacy with a task, the greater the person's motivation to complete that task, and to persist when obstacles present themselves. People with high self-efficacy are more likely to embrace change and pursue personal growth and development (Eun, 2019). This study will focus on teacher self-efficacy with technology integration in the classroom, particularly to determine if the way that teachers are trained to use technology in their undergraduate educator preparation programs affects their level of self-efficacy with technology integration. If Bandura's theory holds true, individuals who completed programs where technology integration was modeled (particularly in the upper-level methods courses), and where students were given the opportunity to continuously practice technology integration, will have higher levels of self-efficacy with technology.

Characteristics of Today's Students

Today's students are digital natives, born into an era of technological innovation and proliferation. Typically, digital natives were born in or after 1980, and are considered digital natives because technology is an integral part of their daily lives (Kirschner & De Bruyckere, 2017). They have access to mobile devices and the Internet, which allows them access to information anytime, anywhere. Research shows that over 78% of American teenagers have a cell phone, and about 93% have access to computers at home (Hur, Shannon, & Wolf, 2016; Pittman and Gaines, 2015).

Students today are more than just passive consumers of digital content; they are creators of content, with the ability to reach audiences all over the world (Cennamo, Ross, & Ertmer, 2019). However, although digital students are continuously inundated with new technology, they are not as technologically savvy as one would suppose that they would be. Their personal use of technology appears to be limited to pursuing entertainment and individual interests, and their ability to use information and communications technologies (ICT) is more limited than has been expected (Kirschner & De Bruyckere, 2017). It is therefore up to teachers to bridge the gap that exists between students' ability to use technology for entertainment and personal purposes, and their ability to use ICT to research, create, communicate, and manage information. Although there is still much interest and research regarding technology integration in schools, the concept is not new.

History of Technology Integration in Schools

The past decade has been active with debates regarding the value of integrating technology in education, but using technology for teaching and learning purposes has been taking place since shortly after the advent of the microcomputer, which made it possible to put more computers in classrooms (Farr & Murray, 2016). In the 1970s and 1980s, the emphasis was on computer literacy and basic computer skills. In recent years, standards have emerged that govern what teachers and students should know and be able to do with technology. The International Society for Technology in Education (ISTE) developed a set of National Educational Technology Standards for students (NETS-S) and teachers (NETS-T), in 1998 and 2000, respectively. Those standards still set the bar for technological competency across the nation. Students are expected to have moved from computer literacy to information literacy, knowing how to find, analyze, use, and communicate information. Teachers are expected to have advanced even further, to the point of integration literacy. They should have the skills necessary to combine the use of computers, mobile devices, digital media, and other technologies with a variety of teaching and learning strategies to enhance students learning (Nelson, Voithofer, & Cheng, 2019; Overbaugh, Lu, & Diacopoulos, 2015; Tondeur, et al., 2019).

Teachers Integrating Technology

Teachers are expected to possess digital competence to achieve integration literacy, which means that they can use ICT and digital media in their instruction. They should also have technology proficiency, pedagogical compatibility, and social awareness (Instefjord & Munthe, 2016). Technology proficiency refers to the extent of teachers' technical competence, and their confidence in using technology, whereas pedagogical compatibility is teachers' understanding and awareness of how technology can contribute to achieving curriculum goals. Social awareness means that teachers understand and can negotiate social aspects of school culture. It is not enough, however, to simply use technology in the classroom. Technology integration involves using technological devices or processes to support, provide instruction for, or assess student learning. It is not enough for a teacher to use presentation software to simply show students the same thing that would have been written on the whiteboard. In such an instance, the teacher used technology, but the method of teaching did not change. The teacher could have created a non-linear, interactive presentation for students to use as a learning or review tool, which would have represented a change in teaching method. It is how the technology is used that makes the difference. The meaningful integration of technology can allow teachers to meet the mandate of developing 21^{st} century skills in their students and differentiate instruction to accommodate the needs of a diverse body of students. Teachers are expected to provide their students with dynamic learning experiences through the use of relevant technologies (Cennamo, et al., 2019; Harris, 2016).

Meeting 21^{st} Century Learning Standards

Today's students are expected to meet 21^{st} century learning standards which include communication, collaboration, critical thinking, and creativity. Students are expected to achieve information, technology, and media literacy, develop leadership skills, and demonstrate innovativeness, all of which are 21^{st} century competencies. Traditional instructional approaches fall short of preparing students to meet 21^{st} century learning standards and achieve 21^{st} century competencies (Harris, 2016). Since digital students consume and create a wide range of digital media in their personal lives, traditional approaches are not very appealing to them.

Teachers, however, often fail to move beyond using technology for their own productivity and creating instructional materials. When teachers are not confident in their ability to use technology, the likelihood increases that their attempts to integrate technology will be ineffective. As much as technology has to offer in terms of improving teaching and learning, it can be just as damaging if not integrated appropriately (Gentry, Baker, Thomas, Whitfield, & Garcia, 2014; McKnight et al., 2016). Integrating technology in the curriculum is a delicate balancing act, and educator preparation programs have a responsibility to ensure that the teachers they graduate can find that delicate balance (Tondeur et al., 2019).

Differentiating Instruction

Technology has the potential to transform the processes of teaching and learning. The role of the teacher is changing in today's classroom: a learner-centered approach inverts the traditional teaching and learning structure. A learner-centered approach places more of the instructional focus on students rather than on teachers, so students have more authority over their own learning. Conversely, with a subject-centered approach, the teacher presents a prescribed curriculum via direct instruction. Teachers who adopt a learner-centered approach to education are more likely to integrate technology within the curriculum. Those who choose a subject-centered approach are less likely to incorporate technology, and if they do, it is merely as an aid to direct-instruction (Ottenbreit-Leftwich, Ertmer, & Tondeur, 2015; Yarbro, McKnight, Elliot, Kurz, & Wardlow, 2016).

The student-centered teacher is keenly aware of the various dimensions of diversity that exist among students in a classroom. Students differ in terms of their cognitive learning styles or preferences, and their learning ability. Technology allows teachers to meet the needs of all students in the classroom regardless of learning style or learning ability. Teachers can differentiate content, processes, or products of learning according to students' readiness, interests, or learning profile. This differentiation can be carried out using a variety of instructional strategies, such as anchor activities or group investigation (Njiku, Maniraho, & Mutarutinya, 2019).

Technological Pedagogical and Content Knowledge (TPACK)

Digital competency for teachers is illustrated by the technological, pedagogical, and content knowledge (TPACK) framework advocated by Mishra and Koehler (Harris, Mishra, & Koehler, 2009). The framework enables teachers to integrate technology via three interdependent components: content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). Content knowledge refers to teachers' familiarity with their subject matter, while pedagogical knowledge refers to an understanding of the processes and practices of teaching and learning. Technological knowledge involves being able to assess and apply information technology productively, and being able to adapt as technology evolves continuously. Each area intersects one with the other, and TPACK is where all three knowledge areas intersect. There is reciprocity in the relationship between content and technology, and TPACK highlights the importance of preparing future teachers to make informed decisions regarding how they incorporate technology when teaching specific content to a specific target group (Tondeur et al., 2019),

Joo, Park, and Lim (2018) contend that teachers are ready to integrate technology effectively when they develop the ability to manage the connections among content, pedagogy, and technology. However, TPACK has its share of critics who feel that technology integration is secondary to well-constructed learning experiences in affecting student learning. They warn that educator preparation programs should not over-emphasize the role of technology in teaching and learning. Research suggests that the more desirable approach is to pair technology with field experiences (Jones, Baek, & Wyant, 2017; Njiku et al., 2019).

Universal Design for Learning (UDL)

Universal Design for Learning (UDL) is defined as “a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn”, and is focused on removing barriers to educational access to meet the needs of all learners (Center for Applied Special Technology [CAST]). Technology is an important facet of UDL because it allows educators to differentiate instruction (Muilenburg, & Berge, 2015). With the various forms of diversity that pre-service teachers will experience in their classrooms, it is vital that educator preparation programs incorporate universal design for learning (UDL) even as they integrate the TPACK model (Benton-Borghi, 2013). Pre-service teachers will face students who are at various points on the spectra of learning styles and abilities. Technological innovations have helped facilitate the inclusion of students with disabilities in traditional classrooms, which means that teachers should universally design instruction to meet the needs of all learners. UDL allows students to express themselves in multiple ways and provides for flexibility in how students demonstrate their learning (Cook, Rao, & Collins, 2017).

UDL was explicitly included in the 2004 reauthorization of the Individuals with Disabilities Education Act (IDEA) to ensure that students with disabilities would be educated in the least restrictive environment and have access to all instructional materials (Cennamo et al., 2019). Educator preparation programs will, therefore, need to change the way they prepare teachers. It is not feasible to expect that teachers will change their beliefs, attitudes, and how they teach if educator preparation programs do not change the way they prepare them for the classroom. With UDL, teacher educators would be required to model teaching with technology (including assistive technology), and pre-service teachers should be required to incorporate UDL and TPACK knowledge in their field experience and clinical activities (Scott, Thoma, Puglia, Temple, & D'Aguilar, 2017).

The Technology Integration Matrix (TIM)

The Florida Center for Instructional Technology developed the Technology Integration Matrix (TIM) as a framework for addressing technology integration within the curriculum (Muilenburg & Berge, 2015). It describes the levels of technology integration as a continuum between teacher-centered and learner-centered instructional strategies. Entry level is the lowest level, where technology is used primarily to deliver instructional content to students. Adoption, the second level, is where teachers evaluate different technologies and select tools and strategies to use with their students to promote procedural understanding. At the adaptation level, technology tools form an integral part of the instruction, and teachers allow students to use and explore technological tools independently. Within the infusion stage, teachers seamlessly integrate a wide range of technological tools into the teaching and learning experience, and with teacher guidance, students can make informed decisions about when and how to use them. The final level is transformation, where the role of technology is to facilitate higher order learning activities that otherwise would not have been feasible.

The TIM delineates the characteristics of an effective learning environment as active, collaborative, constructive, authentic, and goal-directed. In an effective learning environment, students are actively involved in the learning experience, and use technology to collaborate and build knowledge that is tailored to each student's interests and needs. Learning and assessment are relevant to the broader society outside of the classroom, and students are motivated; setting goals, planning, monitoring, and evaluating their own progress (Conner & Sliwka, 2014).

Technologies for the 21st Century Classroom

Today's students have been exposed to technology all their lives. They have grown up playing games on computers, video game systems, and mobile devices, so their minds are wired early on for using mobile technologies. It is, therefore, essential that teachers meet these students in their space. Students are no longer content with sitting still all day listening to teachers talk. They need to be engaged and involved in the educational environment, and teachers incorporating technology in teaching and learning can provide students with the engagement and interactivity that they need (Cennamo et al., 2019). Fortunately, teachers have access to a variety of digital tools and digital media that they can use in the classroom to personalize instruction and help students learn. Digital tools include hardware and mobile devices. Desktop computers (or their mobile counterparts - laptops or notebooks), mobile devices (including tablets and smartphones), and interactive whiteboards are some of the most commonly used digital tools in today's classrooms (Ipek & Ziatdinov, 2017; Martin & Carr, 2015).

Digital media, including Web 2.0 technologies and multimedia software, fosters collaboration, and creativity. Web 2.0 technologies are applications that are available via the Internet, so they are available for use anytime, anywhere. The emphasis of Web 2.0 is on social networking where users can collaborate, create, and share content across the World Wide Web (Hosch, 2018). Multimedia software combines text, graphics, audio, and video to provide an interactive and meaningful experience for the learner (Martin & Carr, 2015). It is necessary for students and teachers to have access to digital tools such as computers and mobile devices that provide the physical platform on which digital media may be used.

Digital Tools

In the late 1980s, there was a shift in attitudes regarding the desktop computer as an educational tool (Young, Hamilton, & Cason, 2017). Computers allow teachers to provide differentiated instruction to a group of diverse students. They also provide teachers with a tool for nurturing students' independence while still maintaining a scaffold when students need assistance. Having computers in the classroom allows teachers to utilize computer-based instruction and computer-assisted instruction for differentiation and to scaffold learning (Belland, Walker, Kim, & Lefler, 2016).

Computer-based instruction is where educational content is delivered to learners via computer software. It is a student-centered instructional approach that allows students to take on more active roles in their learning (Cennamo et al., 2019). Computer-assisted instruction includes the use of specific computer applications to supplement instruction as well as to promote student interest in the content and increase their motivation to learn (Trotti, Hendricks, & Bledsoe, 2017). Both instructional methods are intended to complement teacher-facilitated instruction. The teacher is still essential to the learning process and is responsible for guiding and scaffolding learners as they navigate computer-based or computer-assisted instruction (Cam, Yarar, Toraman, & Erdamar, 2016).

Whereas laptops and notebooks are more mobile versions of desktop computers, tablets are even more mobile because they are typically smaller and lighter. In addition to their portability, tablets allow users to interact with the devices using touch input. Users can interface with the tablets using their fingers, a stylus, or a digital pen. Tablets or other touch-based devices are becoming more popular in classrooms than desktop and laptop computers. The touch-screen input is easier to manipulate than the traditional keyboard and mouse, especially for elementary-aged children, and provides more immediate and extended engagement (McManis & McManis, 2016; Outhwaite & Faulder, 2019).

Smartphones provide for even more mobility than tablets. Today's smartphone is literally a computer in the palm of one's hand. Although many teachers and schools still consider cell phones to be a distraction in the classroom, there is an emerging shift in that attitude. As interest in bring-your-own-device (BYOD) and one-to-one computing grows among educational stakeholders, students are increasingly being allowed to bring their smartphones to the classroom. Smartphones are reported to be the most frequently used mobile device for educational purposes because they are considered a more cost-effective alternative to providing each student with a laptop or tablet computers (Crompton, Burke, & Gregory, 2017; Grant et al., 2015).

Mobile devices, like desktop and laptop computers, may be used to provide a customized learning experience for each student in a classroom. The difference is that with mobile devices, students have the flexibility to learn anywhere and at any time. The flexibility in the instructional experience fosters a truly learner-centered educational environment where teachers can assign instructional tasks based on each student's learning level and allow students to work at their own pace (Hosokawa & Katsura, 2018; Reeves, Gunter, & Lacey, 2017). High-performing students can work independently, freeing the teacher to help those students who need it the most.

Interactive whiteboards have replaced dry-erase boards in classrooms across the country. They typically combine the features of a whiteboard, computer, and projector. Teachers can control the input using any combination of a keyboard, mouse, or the touch-enabled whiteboard display. They can seamlessly switch between different forms of input such as a computer, document camera, or the touchscreen itself (Young, Hamilton, & Cason, 2017). Specialized software allows teachers to use features such as highlighting, annotating, zooming, and handwriting recognition. Teachers can then record, save, and retrieve lessons conducted using the interactive whiteboard (Ormanci, Cepni, Deveci, & Aydin, 2015).

Davidovich and Yavich (2017) described the interactive whiteboard as a cognitive tool that facilitates divergent learning and interaction between students and the subject matter. The interactive nature of these devices allows students to be actively involved in the lessons and helps the teacher keep their attention. As with tablets, students can use the touch-screen input on the interactive whiteboard to manipulate objects, navigate websites, and participate in activities designed by the teacher.

The versatility and interactivity of the interactive whiteboard make it an excellent tool for differentiation in instruction. It allows teachers to meet the needs of students with diverse learning styles and multiple intelligences. Teachers have found that when they use an interactive whiteboard, students are more likely to participate in the lesson. Students report that they like the interactive whiteboard because of how multimedia components can be integrated into the classroom instruction, making learning interactive and engaging. However, it is important to note that if teachers fail to use the interactivity of the device effectively, they run the risk of making the interactive whiteboard just a teacher-centered audio-visual aid, rather than the learner-centered tool that it can be (Aflalo, Zana, & Huri, 2017; Young, Hamilton, & Cason, 2017).

Digital Media

Digital media is comprised of Web 2.0 applications and multimedia software. Web 1.0 refers to a time when the World Wide Web was merely a repository of information. Web 2.0 is the recognition that the World Wide Web has become so much more. The term Web 2.0 encompasses web-based applications that allow students to communicate, collaborate, and create content. These applications include but are not limited to blogs, wikis, social networking, video-sharing, podcasts, and social bookmarking (Bingimlas, 2017; Velasco, 2018). Many of the applications have free or relatively inexpensive options, so teachers can harness their educational potential without having to worry about the price. The low cost also means that students from different socio-economic backgrounds can have access to the applications if they have access to computers or mobile devices that can connect to the Internet (Hu, Oslick, & Wake, 2017).

While teachers and students can access digital media on any device, mobile applications are typically accessed using mobile devices such as tablets and smartphones. Today, mobile devices are prevalent in society because they are affordable and portable. They can easily be connected to the Internet either via a data plan from an internet service provider, a hotspot, or Wi-Fi (Cennamo et al., 2019). Mobile applications are, therefore, immediately and continuously available to users and allow students to communicate with others and explore the world outside of the classroom walls. Students can create and share content on the go, without being restricted by time or space (Crompton, Burke, & Gregory, 2017).

Multimedia is any combination of text, graphics, audio, and video that is designed to provide a multisensory experience for the user (Martin & Carr, 2015), which can be especially useful in the classroom since students learn in different ways. As they learn, students activate different types of learning abilities or intelligences. These include linguistic, musical, logicalmathematical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal intelligences. Students will have marked strengths in some intelligences and considerable weaknesses in others. Typically, they will draw upon a combination of intelligences as they attempt to make sense of the material to be learned (Wilson, 2018). Teachers should be aware of the different types of intelligences and design instruction to tap into a cross-section of the ways that students process information. Multimedia facilitates this process by allowing teachers to provide various forms of sensory input during instruction.

Pedagogical Applications of Digital Media Integration by Subject Area

Although technology is more widely available in the classroom than in previous decades, teachers still are not keeping pace with students' digital use outside of school. Technology is a useful tool for teachers and students, and there are many benefits to be gained by integrating digital media in the elementary classroom. Teachers need specific ideas about how to incorporate technology in an actual classroom (Pittman & Gaines, 2015). This section examines ways in which technology facilitates student-centered teaching and learning, and will provide specific examples of digital applications, by subject area, that teachers can use to support learners. Although each particular benefit of digital media integration is only listed beneath one subject area, it is important to note that the benefits can be realized across subject areas. Most of the examples of digital applications presented in this section are free to teachers and students, although there is typically a paid subscription option if teachers, parents, schools, or school districts wish to access premium features.

Mathematics

Studies have found that early math knowledge is a good predictor of later math achievement. Many elementary students have trouble grasping mathematical concepts, and without early intervention, those students will continue to encounter difficulty as they struggle to learn more advanced concepts (Clements and Sarama, 2016; Outhwaite & Faulder, 2019). Digital media provides options for facilitating the early intervention that many students need in mathematics. In a study conducted by Zhang, Trussel, Gallegos, & Asam (2015), 18 fourth-grade students used Splash Math, Motion Math Zoom, and Long Multiplication to see if there were any improvements in the students' understanding of decimals and multiplication. The results of the study were that all students had performance gains after using the applications, but more importantly, there was a significant decrease in the achievement gap between the typical learners and the struggling learners. Math applications have also been shown to reduce the achievement gap between boys and girls if used during the early educational years (Pitchford, Chigeda, & Hubber, 2019).

Students who struggle with math will typically need more time than is available in an instructional period to understand difficult concepts. Technology provides an opportunity for students to work on learning concepts outside of the classroom and allows more advanced learners to work ahead while the teacher is working with struggling students. For instance, Khan Academy provides free videos that students can use to better understand mathematical concepts on their own time. The videos are free and are usually short, about 7-14 minutes long, enabling students at varying levels of understanding to learn or review a topic by viewing one or several videos. Digital applications also provide opportunities for students to interact with math as they learn to solve problems. Students can quickly sort and analyze data and create digital mathematical models just by clicking to build, drag, rotate, or move various objects, leaving them with more time to focus on solving problems rather than physically drawing or building models (Polly, 2014). Math teachers can use digital applications to scaffold their students' learning, which also allows them to spend more time teaching students how to apply the concepts (Zengin, 2016).

Language Arts

Differentiation involves adapting instruction according to student needs. Language arts teachers will find that students in the same grade are on different levels in their understanding and that the method by which those students learn will also vary. Technology enables teachers to differentiate instruction in terms of content, process, and product (Cennamo et al., 2019). Differentiation in terms of content involves using a digital application to teach concepts across grade levels. For instance, teachers can use digital applications such as Starfall to introduce learners to letters and their sounds, and as students progress from preschool through the elementary grades, it can be used to help them with blending letter sounds and beginning reading. The activities are short, and children work at their own pace. As students experience success, they can move on to more challenging activities (Lamb, 2014; Wood, Grant, Gottardo, Savage, & Evans, 2017). Beginning readers get to read simple but fun short storybooks such as Zac the Rat, and Robot, and Mr. Mole. They can listen to the story as they read along and watch the animated illustrations. More advanced readers can read stories from categories such as magic, music, poetry, tongue twisters, and bird riddles.

In terms of content, differentiating also involves modifying the instruction each student receives within the same classroom, based on their individual learning levels. Starfall can be used in this context to support all readers, including struggling readers. For example, in a reading activity, the text would be displayed on the screen and students would have the option of clicking on a word to hear the pronunciation of just that word, or clicking a sound icon to listen to the entire sentence or paragraph (Millman, Carson-Bancroft, & Vanden Boogart, 2014). With digital applications, students can engage in the same learning activity, but the level at which the activity is to be performed is adjusted to fit each child's individual learning needs. Students will no longer need to feel embarrassed because they cannot answer the questions that are being asked in a class setting. Struggling students can engage in the same activity as the rest of the class and can have the satisfaction of successfully completing the learning task without the entire class, knowing if or how it was modified.

Students have different styles of learning or making sense of what they learn. Some students are visual learners, while others may be aural, verbal, or kinesthetic learners. However, while some students may demonstrate a strong preference for one of the learning styles, most students learn best using some combination of more than one method. A student's learning style or profile may even change over time (Cimermanova, 2018). Digital applications make it possible for teachers to reach and engage all students regardless of their learning style or preference. They allow teachers to utilize multimedia and simulations to present content to students in different forms, and they enable students to show what they have learned using the method that best demonstrates their learning (Cennamo et al., 2019).

An example of an application that teachers can use for differentiation is Bookshare. Bookshare is an application that provides electronic books (e-books) that are available with features such as audio, text-level highlighting, and enlarged font sizes. Students can listen to the text being read as they read along, follow the highlighting, and adjust the speed at which the book is being read (https://www.bookshare.org/cms/bookshare-me/students). The variety of ways in which Bookshare presents text is beneficial to aural, visual, verbal, and kinesthetic learners. Teachers can allow students to use an application of their choice to complete a project. In a study conducted by Millman, Carson-Bankroft, and Vanden Boogart (2014), fourth-grade math students who could freely choose an application to create their presentations used a variety of different tools. They used iMovie to create movie trailers and Keynote to collate pictures and screenshots of drawings they created using other applications. Students also used the iStop motion app to create animated scenes, and BookCreator to create storybooks. The students preferred presenting their work in ways that best represented them and best showcased their understanding, over being told what to do and having to do the same thing as everyone else.

Science

Virtual learning environments can be used to engage students and promote learning in the elementary science classroom. They allow students to perform real-life tasks without penalty of failure, and to go on field trips without leaving class. Students can interact with multimedia scientific content via immersive and engaging media (Parong & Mayer, 2018). Simulations and virtual reality are examples of virtual learning environments that are beneficial to science teachers and students. An example of a virtual learning environment that can be used in the science classroom is Whyville, which combines simulation and virtual reality. It is a virtual city where students can create avatars and explore science simulations, collaborate, and chat with friends, and play games that reinforce scientific concepts. Teachers can join Whyville and get access to materials that help tie the activities to the classroom instruction and the curriculum. Play is essential in learning as it allows elementary students to think and perform beyond their grade levels. Elementary students spend much of their leisure time playing video games, and Whyville has a game-based feel, allowing students to role-play in authentic, real-life situations.

In the 1960s, there was an effort to close the gap in terms of what children did in school and what they did at home. There was also an effort to close the gap in terms of access to educational experiences outside of school walls. Students in socioeconomically disadvantaged schools did not have access to the same out-of-school educational opportunities as students from more privileged backgrounds (Cain, 2017; Dawson, 2017). However, studies showed that most homes had at least one television, though many of those socioeconomically disadvantaged home did not have books. As is the case today, children spent a considerable amount of time watching television. Parents, teachers, and psychologists recognized that television played a significant role in shaping children's attitudes and behaviors, and so they sought to use that influence positively. Television was considered a medium by which children could have access to educational programming at home and in the classroom. The first educational program was Sesame Street, which the creators pedagogically designed to teach children basic foundational content such as letters, shapes, and numbers, while at the same time making the programming fun and engaging (Cain, 2017).

Sesame Street has achieved its objective of cloaking educational content with entertainment. It also has the added benefit of positively influencing children's attitudes and behaviors. Today, educational television is a staple in the lineup of television service providers, and the programming is instructional, entertaining, engaging, and interactive (Cahill & Bigheart, 2016; Cain, 2017). If teachers are knowledgeable of how to incorporate educational videos in the instructional unit, students reap the benefits of having content brought to life via multimedia, which is especially beneficial to early or struggling readers, and students who may not have any external context on which they can draw to make connections with the material they read in books (Cain, 2017; Petrilli, 2016).

The Public Broadcasting Service (PBS) considers itself America's largest classroom. It provides educational programming for children and has a channel for young children called PBS Kids. The kids' channel provides informational kid-friendly shows such as Sid the Science Kid, Wild Kratts, and The Magic School Bus that support children's learning in subjects such as math, engineering, literacy, and science (http://www.pbs.org). PBS Kids also has a website and mobile application where students can go to learn, parents can get ideas on how to support their young learners, and teachers can get ideas and resources for the classroom. On the PBS Learning Media site, an arm of PBS, teachers can choose a subject area and grade level, and access videos, interactives, lesson plans, and other support materials that are free and standards-based.

Teachers can use interactive lessons from the PBS Learning Media site to teach students about things such as animal life cycles. The lesson on the life cycle of a butterfly, for instance, includes videos and illustrations that show the transformation of the caterpillar into a butterfly. One video provides a time-lapsed look at what happens inside the chrysalis. Students get with a puzzle of the caterpillar growth stages that they can sort. When they finish sorting the puzzle, the completed product is stored in a My Work folder so that students can go back and review any such activities that they complete. As they move through the activities in the lesson, students can see the meaning of highlighted vocabulary words by clicking the word. Teachers also get teaching tips, a vocabulary word list, and a list of Next Generation Science Standards that the lesson covers (https://www.pbslearningmedia.org/).

Social Studies

Although there is some debate about the effectiveness of prenatal music therapy, children are often introduced to music even before they are born to kickstart neural development

(Mastnak, 2016). Children enjoy listening to music, and teaching with music is an effective way of making content engaging and memorable for students. Music can elicit emotions and memories, and can aid in information recall (DiDomenico, 2017; Lehmann & Seufert, 2018). Flocabulary is an example of a website that uses music to get students engaged in educational content and to promote retention of the subject matter. The site provides mini lessons on various subjects in the form of rap videos. The raps are catchy and informative. In the area of social studies, teachers have access to lesson plans, videos, and activities that cover history, geography, civics, holidays, and economics. The site also provides ideas for encouraging students to write their own rap songs to help remember a topic (http://www.flocabulary.com). For students who have difficulty expressing themselves using other media, music provides an alternative medium for students to demonstrate an understanding of a concept. Students can write songs based on an event in history, for example (DiDomenico, 2017).

Assessing Students with Technology

Feedback is a crucial component of student learning. It is important for both teachers and students to know what students understand, and what they need to improve their understanding (Nyland, 2018). Immediate feedback provides the opportunity for students to gauge their grasp of a concept instantly and allows teachers to adjust instruction in real-time based on how well students understand the material. When teachers obtain continuous informal feedback from learners, they are engaging in formative assessment. Through formative assessments, teachers can determine which areas may need to be revisited to improve learning. Teachers can use feedback from educational websites or software and mobile applications to inform their instructional practice and enhance the learning experience for students. The data that teachers collect during formative feedback can assist the teachers in differentiating instruction (Reeves, Gunter, & Lacey, 2017; Stover, Yearta, & Harris, 2016).

Digital technology provides an avenue for teachers to conduct a formative assessment that is multimodal, and that can be conducted within the classroom or outside of the instructional block. Using digital technology merely to deliver traditional assessments does nothing towards fully harnessing the power of technology. The effective use of technology for assessment involves using digital technology to embed interactive performance tasks within the assessments and ensuring that the design of the assessments reflects sound pedagogical principles. When teachers use technology for formative assessment, they create an environment where students can demonstrate their achievement and progress in multiple ways, often without time or location constraints (O'Leary, Scully, Karakolidis, & Pitsia, 2018; Reeves, Gunter, & Lacey, 2017; Timmis, Broadfoot, Sutherland, & Oldfield, 2016). Preservice teachers should be adequately equipped with a knowledge of the hardware and software pertinent to formative assessment, and it is necessary for them to have a thorough understanding of formative assessment and related pedagogies (Dalby & Swan, 2019).

Virtual learning environments, such as iCivics, provide opportunities for students to solve authentic problems in a virtual environment. ICivics is an interactive website that students can access anytime, anywhere. Teachers can find games, interactives, and standards-based lesson plans for lessons in civics. They can search the site by content or by state standards, and they can find interactive activities that include the context and purpose of the lessons, as well as tips and practice to help them differentiate the lessons (Lamb, 2014). In iCivics, students get to play games such as Activate, where they choose an issue for which they have to lead a campaign, grow a movement, and make a difference, or Immigration Nation, where they help immigrants aspiring to become citizens along the path to citizenship. At the end of each activity, students get a certificate showing information such as playtime, total points, opponent points, and special support connections attempted and correct. Teachers can require the certificates as evidence of the students' completion of the activity and can use the certificates as a means of assessing student comprehension of the topic (https://www.icivics.org).

The certificates that students get at the end of each activity in iCivics are examples of digital badges. Digital badging is a form of assessment where students independently perform a task or solve a problem in a digital environment, and upon successful completion of the activity, receive a badge as a symbol of achievement. Though teachers may assign a grade to the activities, digital badges go beyond the traditional practice of assigning alphabetic or numeric grades. Digital badges belong to the students and should be used as evidence of skill, experience, or achievement in future classes, higher grade levels, or even during employment searches (West-Puckett, 2016).

Free-response systems such as clickers and web-based or app-based systems such as Plickers, Socrative, or GoFormative facilitate formative feedback in the classroom environment. The web- and app-based free-response systems require the use of mobile devices such as smartphones, tablets, or laptops, and the devices may need only a QR code reader or a program that enable the devices to function as clickers so students can respond to questions about the lesson (Robinson, 2018). Teachers can choose to have the programs identify students by name and associate them with their answers, or they may elect to have students respond anonymously. When responses are anonymous, students who would usually avoid answering questions verbally are more likely to respond since no one will know who answered the questions correctly and who did not (Johns, 2015). For student work outside of the classroom, teachers can use embedded quizzes for instant feedback, and game-based learning that delivers authentic and meaningful feedback in the form of student reports and dashboards. Teachers can use the reports and dashboards to direct students toward a deeper understanding of the subject matter (Groff, 2018; Nyland, 2018). EdPuzzle lets teachers embed quizzes in videos that the teachers create or that already exist in the EdPuzzle library. Websites such as Sumdog use game-based learning to facilitate adaptive learning by presenting students with questions targeted to their individual levels. Teachers can differentiate the assessments and instructions by student, and teachers and students can view the results and monitor progress (Mitten, Jacobbe, & Jacobbe, 2017). In most cases, when teachers use technology for formative (and summative) assessment, they are able to collect individual data that they can use to track each student's progress over time, as well as aggregate data that can be used to reflect on the effectiveness of the instructional unit (Timmis, Broadfoot, Sutherland, & Oldfield, 2016).

Barriers to Technology Integration

Several barriers exist that prevent teachers from integrating technology into the curriculum. These barriers are categorized into first-order and second-order barriers. First-order barriers include a lack of access to technology, support, and professional development. Second-order barriers include teachers' lack of confidence using technology, and the low value that teachers perceive that technology has on student learning (Hur, Shannon, & Wolf, 2016).

Educator preparation programs can address those barriers that are internal to pre-service teachers, which include self-efficacy, beliefs, and attitudes. In a policy brief on advancing educational technology in teacher preparation, the Office of Educational Technology (OET) emphasized that educator preparation programs have a responsibility to prepare teachers across all grade levels to integrate technology in teaching and learning effectively. As such, teacher education faculty should stay abreast of technological innovations that can contribute to learning and achievement and should model technology integration for pre-service teachers (U.S. Department of Education, 2016).

Federal and Statewide Efforts to Promote Technology Integration

The federal government has made several efforts to promote technology integration in schools. In 1993, the publication of A Nation at Risk: The Imperative for Educational Reform was published by the National Commission on Excellence in Education. The Commission found that integrating technology in the classroom was a priority for education in the United States. It recommended that high school students be required to take a computer course to graduate and that there be a focused effort to include technology integration in new teaching materials (Bakir, 2016). In 2001, President George Bush signed the No Child Left Behind NCLB) Act into law. Included in that act was The Enhancing Education through Technology (EETT) Act that provided grants for states that outlined a long-range plan for ensuring ongoing integration of instructional technology and strategies into the curriculum. In addition to ensuring that all students are technology literate by the time they get to the eighth grade, the EETT aimed at improving teachers' ability to integrate educational technology to raise student achievement (U.S. Department of Education, 2016).

The (OET) was created within the U.S. Department of Education as a requirement of the Goals 2000 Act of 1994. Today, the office is charged with developing national educational technology policy. In its *2017 National Education Technology Plan Update*, the OET established that as far as educational technology is concerned, it is no longer a question of whether the technology should be integrated, but how it can be used to improve teaching and provide learning opportunities for all students. The Department of Education insists that students in P-12 classrooms deserve to have teachers who, upon entering the workforce, are able to meaningfully and effectively select and use the most appropriate technological applications and digital tools in their classrooms (Wilson, Richman, Kimmons, Atkins, & Estes, 2018).

The state of North Carolina passed House Bill 23 in 2013. The Bill required the State Board of Education to develop a set of digital teaching and learning competencies that would guide schools of education, teachers, and administrators regarding the skills needed to provide effective integrated digital teaching and learning. In 2016, the State Board of Education approved the Digital Learning Competencies for Classroom Teachers and the Digital Learning Competencies for Educators. Teachers and Administrators are expected to meet these competencies and use them to improve instruction and promote student learning (North Carolina Department of Public Instruction, n.d.). The major focus areas for the Digital Learning Competencies for Classroom Teachers are leadership in digital learning, digital citizenship, digital content and instruction, and data and assessment.

The Role of the Educator Preparation Programs

Educator preparation programs are tasked with preparing future teachers. In an ever-increasingly technological and connected world, the teachers of today and tomorrow will be expected to have the skills necessary to integrate technology in the classroom. Teaching a digital generation of students requires teachers to incorporate the tools that students use in their daily lives, and that they will use when they enter the workforce. The role of educator preparation programs is to ensure that the teachers they graduate have the technological, pedagogical, and content knowledge that is required to integrate technology effectively. Effectively infusing technology in the undergraduate curriculum would enable educator preparation programs to prepare future teachers who are confident with their ability to integrate technology in their classrooms (Trainin, Friedrich, & Deng, 2018; Yu & Okojie, 2017).

The Interstate Teacher Assessment and Support Consortium (InTASC)

The Interstate Teacher Assessment and Support Consortium (InTASC) identified a set of core teaching standards that serve as the model for what effective teaching and learning should look like in a 21st-century classroom. The standards focus on creating personalized learning experiences for diverse learners, developing a stronger focus on the application of knowledge and skills, improving assessment literacy, fostering a collaborative professional culture, and establishing new leadership roles for teachers and administrators (Council of Chief State School Officers, 2011). Although InTASC does not explicitly list it as one of the standards, technological literacy is a concept that is implicit across all standards, particularly those that address personalized learning for diverse learning and application of knowledge and skills.

InTASC and regional accreditation agencies govern the knowledge and skills that teachers are expected to have upon entering the workforce. Teachers are expected to employ 21st-century teaching skills that include strategies and processes needed to develop 21st century learners. Integration literacy is a crucial component of pre-service teacher preparation. Given the opportunity to use technology in authentic environments, pre-service teachers develop greater technology integration self-efficacy. Educator preparation programs should provide opportunities for pre-service teachers to learn and practice technology integration (Han, Shin, & Ko, 2017).

Council for the Accreditation of Educator Preparation (CAEP)

The Council for the Accreditation of Educator Preparation (CAEP) accredits most of the nation's schools of education. CAEP is the result of the 2013 merger of the National Council for

Accreditation of Teacher Education (NCATE) and the Teacher Accreditation Council (TEAC), each of which was an option for educator preparation programs that sought to gain accreditation (Schwarz, 2016). The Council includes ensuring that candidates model and use technology as a part of Standard 1: Content and Pedagogical Knowledge, but the Council also explicitly states that it considers diversity and technology as cross-cutting themes that should be interwoven in every aspect of an educator preparation program. Schools of education are expected to address how they integrate technology in each of the five standards that are required in the CAEP self-study process. CAEP expects that technology integration is embedded throughout the teacher education program (Council for the Accreditation of Educator Preparation, 2016).

Stand-Alone Course or Technology Infusion Approach

Most schools of education provide only one stand-alone course in instructional technology for their pre-service teachers, even though such an approach has been proven ineffective in preparing them for effective technology integration. It is not enough to teach pre-service teachers how to use technology. They should get the chance to understand how technology interrelates with pedagogical and content knowledge (Admiraal et al., 2017; Nelson, Voithofer, & Cheng, 2019; U. S. Department of Education, 2017).

Advocates of the technology infusion approach contend that teacher educators are vital in preparing and motivating future teachers to integrate technology, and should model the use of technology so that pre-service teachers can observe how it can be used to enhance the teaching and learning environment (Tondeur et al., 2019). On the part of the teacher educator, modeling of the use of technology should be so intentional that pre-service teachers can collaboratively reflect upon and discuss the experience. It is, therefore, very important that teacher educators possess strong technology integration skills. Pre-service teachers should be given a chance to evaluate the effectiveness and value of different technologies and strategies, and design curriculum materials that integrate technology in a low-threat environment (Estes & Dailey-Hebert, 2018; Tondeur, Roblin, Braak, Voogt, & Prestridge, 2017).

The aim is not to imply that a course in instructional technology is not beneficial for pre-service teachers. In fact, such a course can serve as an introduction to computers and educational technology, especially for digital immigrants or students who have little experience with computers, and who are uncomfortable with the thought of using technology in the classroom. Teachers do need to have basic computer and technology training, as such training reduces the anxiety that they feel about learning to integrate technology in the curriculum (Zogheib, 2015). However, it is crucial that preservice teachers learn to connect the technology to the content and the pedagogy. Yu and Okojie (2017) contend that teachers should be able to choose technologies that are content-specific and guided by pedagogical principles.

Technology Transience

Technology is dynamic. The nature of technology is such that the speed at which innovations arise and become obsolete makes it challenging to prepare pre-service teachers to use a specific tool or set of tools. The term coined for this phenomenon is technology transience A primary concern with technology transience is that the gap that exists between the technology available to the broader society and the technology in use in schools is widening (Muilenburg & Berge, 2015). The TPACK framework provides teacher educators with a roadmap for giving pre-service teachers the ability to evaluate technological innovations as they arise, and to determine if those innovations fit into their framework of content and pedagogical knowledge (Amirault, 2015). While this does not necessarily close the gap created by technology transience, it equips pre-service teachers with the tools they need to adapt quickly to new technologies introduced within the educational arena.

Muilenburg and Berge (2015) suggested four strategies for addressing technology transience. The first strategy is to nurture a fundamental shift in thinking about technology. Pre-service teachers should be free to explore technology. Teacher educators should model a positive attitude toward the dynamic nature of technology. Both teachers and students should understand that technology will fail and be prepared for that. It is also vital for teacher educators to stay current with technology in the content area and encourage pre-service teachers to do so as well. The second strategy is to develop technology fluency and adaptability. There should be a focus on UDL and allowing students options for creating products of learning. The third strategy is infusing TPACK throughout the educator preparation program, not just in a stand-alone technology course or in a single methods course. Finally, the educator preparation program should be designed to utilize a developmental approach to TPACK. An e-portfolio is a tool that allows students to track their progress in an area over time. The use of e-portfolios may be a useful approach to addressing technology transience since preservice teachers can use them to document their growth in technology integration throughout their educator preparation program (Muilenburg & Berge, 2015).

Pre-Service Teacher Self-Efficacy

Research has established that when teachers have positive experiences and attitudes towards technology, they are more likely to use technology effectively for teaching and learning in the classroom (Savage, 2016). Whether teachers choose to integrate technology is often greatly influenced by their experiences in their educator preparation programs (Instefjord & Munthe, 2016). Educator preparation programs are the ideal avenues for nurturing positive interactions with technology and technology integration. However, educator preparation programs find it difficult to provide sustained learning opportunities in technology integration for pre-service teachers (Tondeur et al., 2017). In many instances, teacher educators themselves have low self-efficacy with technology and technology integration, and so are not able to provide the level of modeling and practice that pre-service teachers need to increase their levels of comfort with technology integration (Foulger, Graziano, Schmidt-Crawford, & Slykhuis, 2017; Uerz, Volman, & Kral, 2018).

Technology self-efficacy refers to the level of confidence teachers have in their ability to integrate technology in their classrooms in a meaningful way (Hur et al., 2016). The pre-service experience can have a profound impact on teachers' self-efficacy in using instructional technology. Current pre-service teachers are, for the most part, also digital natives. They, too, were born in an age of technological innovation, and as such, are more amenable to using technology in their classrooms. The issue is that having an influx of teachers who are digital natives is not translating to increases or improvements in technology integration (Tondeur et al., 2017).

The factor that may be at the root of this dissonance is that digitally native pre-service teachers are not empowered to go beyond computer or information literacy to integration literacy. In response to mandates by teacher education accrediting bodies, educator preparation programs developed technology courses for their pre-service teachers. However, in most cases, those courses focused more on technology skills than on teaching and learning with technology. There was no connection to methods courses, and although it is beneficial to increase pre-service teachers' technology skills, those skills alone do not prepare future teachers to integrate technology in their classroom practices (Sun, Strobel, & Newby, 2017). Many pre-service teachers graduate from their educator preparation programs and encounter reality shock when they enter the classroom, finding that they are being asked to integrate technology that is far beyond what they were exposed to in their programs. The result is that teachers have low self-efficacy with technology integration because they are not confident that they can do so in ways that effectively impact teaching and learning. Most of the learning about technology integration, therefore, takes place after the teachers have entered the field (Admiraal et al., 2017).

Teacher educators should encourage pre-service teachers to make a connection between content knowledge and instructional strategies. There should not be a disconnect between content and pedagogy. Instead, methods courses and the student teaching experience should be designed in such a way that pre-service teachers see their instructors, mentors, and supervising teachers in the field modeling effective technology integration. The methods courses and field experiences should also allow pre-service teachers to practice what was modeled for them. Han et al. (2017) found that when pre-service teachers have student-teaching experiences that provide them with the opportunity to observe an in-service teacher effectively using technology in the classroom, and practice technology integration themselves, those pre-service teachers experienced an increase in technology integration self-efficacy. Allowing pre-service teachers to practice technology integration through lesson planning was found to increase their technology integration self-efficacy (Janssen & Lazonder, 2016). Pre-service teachers could practice creating technology-infused lesson plans in their methods courses. They would have the benefit of practicing technology integration in a non-threatening environment and would be able to get feedback and advice from their peers and instructors.

Schools of Education in North Carolina should actively seek ways of providing more opportunities for pre-service teachers to observe and practice technology integration. Most programs across the country appear to equip students with basic computer skills rather than technology integration skills. As a result, beginning teachers tend to use technology for preparation and productivity rather than as an instructional tool (Han, et al., 2017; Tondeur et al., 2017). Perhaps pre-service teachers will show an increasing trend in technology integration self-efficacy throughout the baccalaureate program if they get continuous exposure to examples of technology integration, and if they get opportunities to practice technology integration themselves (Han, et al., 2017).

Summary

Today's P-12 students are members of a digital generation who learn differently from students in generations past. Teachers should adopt and adapt technology within the teaching and learning environment to engage the students and prepare them for the technological world in which they will live. If future teachers are to develop the mindset and self-efficacy needed to integrate technology effectively, educator preparation programs should better equip them to do so. Based on Bandura's social learning theory, faculty in educator preparation programs should model technology integration, and provide authentic opportunities in methods courses and field experiences/student teaching for pre-service teachers to practice technology integration.

The students that pre-service teachers will face in the classroom will be digital natives, who have been exposed to technology all their lives. They are creators of content rather than just passive consumers. They live in a world where, because of technology, there are no boundaries. Future teachers should, therefore, be skilled in meaningfully integrating digital tools and digital media to meet the multimodal needs of learners, differentiate instruction, and assess student learning. However, too many teachers are leaving their undergraduate programs lacking in their confidence to integrate technology in their teaching and learning effectively. Educator preparation programs should work to improve pre-service teachers' technology integration self-efficacy, beliefs, and attitudes.

Educator preparation programs have been mandated by the federal government to ensure that pre-service teachers are confident in their ability to integrate technology once they transition to the classroom. States also fall under this mandate. The North Carolina legislature is examining ways to improve technology integration within PK-12 classrooms, and 4-year educator preparation programs in North Carolina should determine the best way to meet the mandate. One decision that these colleges and universities need to make is whether to utilize a single technology course or to infuse technology throughout the educator preparation program. To help inform that decision, the purpose of this proposed research will be to determine if there is a difference in teacher technology integration self-efficacy based on whether their programs provided just a stand-alone course or infused technology throughout the curriculum. The next chapter will detail the methodology to be used to conduct the study.

CHAPTER THREE: METHODS

Overview

In this research study, a causal-comparative design was used to determine if there is a relationship between beginning teacher self-efficacy with technology and the level of technology infusion in their undergraduate programs. Participants for the study were chosen from a large school district in southeastern North Carolina and were asked to complete a survey to determine their self-efficacy with technology integration in the classroom. The levels of technology integration infusion in the undergraduate programs reported by the study participants (dedicated technology course, technology infusion throughout the program, dedicated technology course and technology infusion throughout the program) were used to determine if there is a difference in technology integration self-efficacy among beginning teachers who graduated from those programs. The design of the study is discussed, and the research question and hypotheses are reviewed in this chapter. This chapter also includes information on the participants and setting of the study, the instrument that was used to capture data on the dependent variable (technology self-efficacy), the procedures that were followed, and how data was analyzed.

Design

The study utilized a non-experimental ex-post facto causal-comparative design. There was no control group, and no manipulation of the independent variable took place, so the design was non-experimental. With ex-post facto research, there is no manipulation of the independent variable because the characterizing event has already taken place and there is no random assignment to the different groups (Gall, Gall, & Borg, 2007; Haynes, Robinson, Edwards & Key, 2012; Wachter Morris & Wester, 2018). In the case of this study, the independent variable was the level of technology integration in the undergraduate educator preparation program, and the participants had already completed their undergraduate programs. The researcher did not have any control over the group into which each participant fell, so the study was ex-post facto.

There are three categories of the factor or independent variable (level of technology infusion in the undergraduate program) within which a beginning teacher's educator preparation program might fall, which will be measured on an interval scale. The beginning elementary teachers have completed one of the following types of undergraduate program: (a) an undergraduate program that had a single course dedicated to teaching technology integration; (b) an undergraduate program that infused technology integration throughout the curriculum, or (c) an undergraduate program that had both a dedicated technology course and technology infusion. This factor is considered a fixed factor because the categories represent the range of possible levels of technology infusion in an undergraduate educator preparation program, except for where there is neither a dedicated technology course or technology infusion in the program (Warner, 2013). A review of the self-reporting by the educator preparation programs within the state of North Carolina did not reveal any programs with no technology integration at all.

The measurement of technology self-efficacy was in quantitative terms, and while the Likert scale falls somewhere between ordinal and interval, there have been no issues reported with using the scale in parametric statistics. Results obtained from instruments using Likert scales have been found to provide useful and valid results (Warner, 2013). The use of the TTES is acceptable for this study, as Gall et al. (2007) assert that questionnaires may be used for data collection.

Research Question

The research questions for this causal-comparative study were as follows:

RQ1: Is there a difference in technology integration self-efficacy scores among beginning elementary school teachers by level of technology infusion in the undergraduate educator preparation program (dedicated technology course, technology infusion, or dedicated technology course plus technology infusion) as measured by the Technology and Teaching Efficacy Scale (TTES)?

Hypothesis

The null hypothesis for this study was:

$H_0$1: There is no statistically significant difference in technology integration self-efficacy scores among beginning elementary school teachers by level of technology infusion in the undergraduate educator preparation program (dedicated technology course, technology infusion, or dedicated technology course plus technology infusion) as measured by the Technology and Teaching Efficacy Scale (TTES).

Participants and Setting

Population

The participants for this study were beginning elementary school teachers who graduated from a four-year educator preparation program. In North Carolina, there is a three-year induction program for new teachers, who are considered beginning teachers during that induction period (Public Schools of North Carolina, 2016). It is that definition of beginning teachers that will be used for this study; teachers within the first three years of their teaching careers. A convenience sample was drawn from the population of beginning elementary school teachers in one of the largest public-school systems in southeastern North Carolina.

Upon approval from the institutional review board (IRB) and the school system, electronic surveys, including a consent form, were sent to the beginning teachers through the Beginning Teacher Coordinator for the school system. Participation in the study was voluntary for the teachers.

With more than 50,000 students and 3,000 teachers, the school system is one of the top five largest school districts in the state, and one of the top eight for diversity. The school district website listed the demographic make-up of students for the 2017-2018 school year as 45.09% black, 29.07% white, 13.47% Hispanic, 1.86% Asian, 1.64% Native American, .50% Hawaiian/Pacific Islander, and 8.37% Two or More. Approximately 75% of the students receive free or reduced meals, and 14.4% receive exceptional children's services. There are 52 elementary schools in the school system, and elementary students comprised 47% of the system's total enrollment. The teacher turnover rate for elementary schools was 17%, and 31.5% of the system's elementary school teachers had three years or less of classroom teaching experience.

Sample

This study surveyed 126 beginning teachers, which according to Gall et al. (2007, p. 145), is the required minimum for a medium effect size with a statistical power of .7 at the .05 alpha level. According to Gall et al. (2007), there should be at least 15 participants in each group in causal-comparative research, and this study met that criterion. The sample of beginning teachers that was used in this study was a convenience sample drawn from one of the largest and most diverse school systems in North Carolina. The sample consisted of 24 males and 102 females. The average age of the sample was between 35 and 44 years old, and the average number of years of teaching for the sample was 3 years.

Group 1 (Dedicated Technology Course)

The dedicated technology group consisted of teachers for whom the undergraduate program included only a dedicated course for instructional technology. The group consisted of 11 males and 26 females. In terms of their reported ages, there were 6 participants in the 18-25 age group, 16 in the 25-34 age group, 12 in the 35-44 age group, 1 in the 45-54 age group, and 2 in the 55-64 age group. There were 4 teachers who had been teaching for less than a year, 5 who had been teaching for a year, 7 who had been teaching for 2 years, and 21 who had been teaching for 3 years.

Group 2 (Technology Infusion)

The technology infusion group included teachers whose undergraduate programs did not have a dedicated technology course. Instead, instructional technology integration was infused across methods courses. The group consisted of 5 males and 17 females. Of the participants in this group, 5 were in the 18-24 age group, 8 in the 25-34 age group, 3 in the 35-44 age group, 3 in the 45-45 age group, and 3 in the 55-64 age group. Three teachers reported having less than one year of teaching experience, six reported having one year of experience, four reported having two years of experience, and nine teachers reported having three years of experience.

Group 3 (Dedicated Technology Course Plus Technology Infusion)

The teachers in the dedicated technology course plus technology infusion group were required to take a dedicated instructional technology course during their undergraduate programs, but also had instructional technology-infused across methods courses. The group consisted of 8 males and 59 females. Within this group, 8 teachers were 18-24 years old, 30 were 25-34 years old, 13 were 35-44 years old, 13 were 45-54 years old, and 3 were 55-64 years old. There were 13 teachers who had been teaching for less than a year, 6 who had been teaching for a year, 15 who had been teaching for 2 years, and 33 who had been teaching for 3 years.

The demographic information for each group is summarized in Table 1.

Table 1

Demographic Information for Teachers by Group

		Group 1	Group 2	Group 3
Gender	Male	11	5	8
	Female	26	17	59
	Total	37	22	67
Age Group	18-24	6	5	8
	25-34	16	8	30
	35-44	12	3	13
	45-54	1	3	13
	55-64	2	3	3
	Total	37	22	67
Teaching Experience	Less than 1 year	4	3	13
	1 year	5	6	6
	2 years	7	4	15
	3 years	21	9	33
	Total	37	22	67

Instrumentation

While the topic of factors influencing teacher integration of technology has been well researched, there is a gap in the research on what contributes to the presence or absence of those factors. One of the factors that affect teachers' integration of technology is their self-efficacy. This study investigated if there is any relationship between how teachers are prepared for technology integration in their undergraduate programs and their self-efficacy with technology. In general, self-efficacy has proven to be problematic to measure. There have been several instruments developed, but problems have arisen with each in terms of construct, validity, and reliability (Tschannen-Moran & Woolfolk Hoy, 2001). Similarly, the existing studies on teacher self-efficacy, specifically with technology, use a multitude of different instruments as there has not been a consensus on the best instrument for measurement. Researchers have simply either adapted existing self-efficacy tests or created their own instruments for measuring technology self-efficacy, many specific to particular subject areas. Few of these tests are specific to behavior, and even fewer are specifically aligned with the International Society for Technology in Education's standards for teachers (Gentry, Baker, Thomas, Whitfield, & Garcia, 2014).

Although there were several instruments available for assessing teachers' self-efficacy with technology, the Technology and Teaching Efficacy Scale (TTES) was selected because other instruments used in prior research were limited to measuring teacher technology use or attitudes rather than true self-efficacy. The TTES consists of 22 items on a 5-point Likert-type scale; the total scores range from 22 to 110. Total scores closer to 22 indicate that the teachers have low self-efficacy with technology integration, while total scores closer to 110 indicate teachers are highly self-efficacious with technology. Developed and tested by Tanguma, Underwood, & Mayo (2004), the instrument has a Cronbach's alpha of .98, indicating strong internal validity. The scale was used in a longitudinal study geared at increasing pre-service teachers' technology integration self-efficacy through a technology training program, and a study of a particular course design's impact on pre-service teachers' technology self-efficacy (Mayo, Kajs, & Tanguma, 2005; Willis, 2015).

Two subscales comprised the TTES: (a) the Use of Technology Efficacy Scale, and (b) the Teaching Efficacy Scale. Each subscale consisted of 11 questions with total scores for each section ranging from 11 to 55. The use of technology efficacy scale included items such as "I am able to use technology to capture a student's interest" and "Students are successful in my classes because of my ability to effectively incorporate technology into my teaching." Items on the teaching efficacy scale included "I vary my teaching strategies to meet the needs of my students" and "Even students with poor academic records can benefit from my teaching." Response options on the TTES were Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree, rated on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). This study utilized the 11 questions that comprised the Use of Technology Efficacy Scale, as the nature of the items included in that section of the TTES made it the closest match for data collection for this study (Appendix A). The survey took approximately 10 minutes to complete. Permission to use the survey was granted by one of the developers before dissemination to beginning teachers (Appendix B).

Procedures

With the written permission of the authors, the Use of Technology Efficacy Scale, a subset of the Technology and Teaching Efficacy Scale (TTES), was administered to the participants in this study. Before the administration of the survey, permission was obtained from the school system's central office (Appendix C) and Liberty University's Institutional Review Board (IRB) (Appendix D). Once the central office granted permission and Liberty's IRB approved the proposal, the 11-item survey including an informed consent form and additional items for collecting demographic information was emailed to the Beginning Teacher Coordinator at the central office (Appendices E-G). The Coordinator electronically disseminated the survey to the beginning elementary teachers with no more than three years of teaching experience.

All efforts were made to create a subject line for the email sent to teachers requesting their participation, to be attention-getting. The body of the email properly informed participants of the intent of the study, explained the survey, and was crafted to evoke an emotional response that encouraged teachers to participate. The email included a link to the survey, and the first page of the survey included a link to the downloadable informed consent form. The participants then had the option of indicating their consent by proceeding with the survey or closing the survey. The survey took approximately 10 minutes for the teachers to complete, included the question items that captured demographic information.

Beginning teachers who completed the survey were eligible to be entered in a drawing for one of three $100 Visa gift cards. The emails for the gift card drawing were collected separately from the survey responses in the study to ensure teacher anonymity. No identifying data was collected. The survey remained open for four weeks. Data collected from the survey was exported from Qualtrics into SPSS. Within SPSS, the data was visually examined, and incomplete responses were removed. In accordance with Liberty University's dissertation policy, all data collected will be stored in a secured area for three years, after which they will be destroyed.

Data Analysis

This study utilized a one-way between-subjects analysis of variance (ANOVA) for analyzing the data collected from the surveys. According to Gall et al. (2007), an ANOVA is used to compare more than two means. It compares the between-group variances in individual scores with within-group variances in those same scores. Warner (2013) stated that ANOVAs are appropriate for studies such as this one, where the means of groups that are naturally occurring are being compared, and where participants are members of only one group. Data from the study were analyzed to see if the mean technology self-efficacy scores of beginning elementary school teachers from each type of undergraduate teacher education program differed significantly.

A total technology integration self-efficacy score was calculated for each teacher by summing the responses to the 11 survey questions. The range of possible scores was from 11 to 55, with a score of 11 indicating low technology integration self-efficacy, and a score of 55 indicating a high level of technology self-efficacy. A box and whisker plot of the total scores was used to determine if there were any outliers in the data. One outlier was identified and removed. The normality of the data distribution was tested using a Kolmogorov-Smirnov test since the number of participants was greater than 50 (Warner, 2013). The Kolmogorov-Smirnov test indicated that there was a violation of the assumption of normality of distribution, so frequency histograms were created to provide a visual check of the shape of the distribution. The histogram showed the shape of the distribution curve to be acceptable, and this was supported by calculated skewness and kurtosis scores that fell within the acceptable range for normality of distribution. A Levene's test was used to test the assumption of equality of variance, and the test determined that there was no violation of the assumption.

Descriptive statistics were used to examine the mean and standard deviation of the survey scores. If the ANOVA yields a difference between means by way of a significant F ratio, it is advisable to conduct follow-up testing via a t test for multiple comparisons (Warner, 2013). For this study, the results of the ANOVA were examined, and since none of the differences in the means were found to be significant, no post hoc testing was conducted. Partial Eta squared (η^2) was used to calculate effect size with an alpha (α) of .05 (Warner, 2013). The sample size met the minimum (126 participants) that is required to achieve a medium effect size for a study utilizing a one-way analysis of variance (ANOVA) with three groups, with a statistical power of .7 at the .05 alpha level (Gall et al., 2007). All tests were run at the 95% confidence level.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this nonexperimental causal-comparative study was to determine if there was a statistically significant difference in the technology self-efficacy scores of beginning elementary school teachers based on the level of technology integration instruction in their undergraduate programs. The beginning teachers completed the Technology and Teaching Efficacy Scale (TTES), an 11-question survey. The scores were analyzed using Microsoft Excel (Excel) and a one-way Analysis of Variance (ANOVA) in SPSS Version 26.

Research Question

RQ1: Is there a difference in technology integration self-efficacy scores among beginning elementary school teachers by level of technology infusion in the undergraduate educator preparation program (dedicated technology course, technology infusion, or dedicated technology course plus technology infusion) as measured by the Technology and Teaching Efficacy Scale (TTES)?

Hypothesis

$H_0$1: There is no statistically significant difference in technology integration self-efficacy scores among beginning elementary school teachers by level of technology infusion in the undergraduate educator preparation program (dedicated technology course, technology infusion, or dedicated technology course plus technology infusion) as measured by the Technology and Teaching Efficacy Scale (TTES).

Descriptive Statistics

A total of 156 beginning elementary school teachers from a large district in the southeastern United States attempted the survey. Of that number, 18 teachers did not complete the survey, 11 teachers indicated that they had no technology integration training or did not complete a four-year teacher education program, and one submission was identified as an outlier on the initial box and whisker plot. All invalid or incomplete responses were removed, as was the outlier that was identified. A total of 126 survey responses were analyzed for this study.

Frequencies of Demographic Information

Table 2 shows frequencies for the respondents by gender, age group, teaching experience, and level of technology infusion in t

he undergraduate program.

Table 2

Frequency by Demographic Information

Demographic	Group	Frequency	Percent
Gender	Male	24	19.0
	Female	102	81.0
	Total	126	100.0
Age Group	18-24	19	15.1
	25-34	54	42.9
	35-44	28	22.2
	45-54	17	13.5
	55-64	8	6.3
	Total	126	100.0
Teaching Experience	Less than 1 year	20	15.9
	1 year	17	13.5
	2 years	26	20.6
	3 years	63	50.0
	Total	126	100.0
Level of Technology Infusion	Class	37	29.4
	Infusion	22	17.5
	Class and Infusion	67	53.2
	Total	126	100.0

Total TTES Scores

The original TTES consisted of 22 questions, 11 of which dealt with teaching self-efficacy, and 11 of which dealt with technology self-efficacy. For this study, only the questions pertaining to technology self-efficacy were used. Each teacher's total technology self-efficacy score was calculated by summing the values for the responses to the survey. The possible range of total scores was 11 to 55, with a higher score indicating a higher level of technology integration self-efficacy. Table 3 shows the means and standard deviations of the total scores for each group of teachers. The group of teachers whose teacher education program included just a dedicated class for technology integration had a mean total technology self-efficacy score of 47.97 (SD =5.829, N = 37). The mean score for the group of teachers who had no dedicated class for technology integration, but whose instructors infused technology across the methods courses was 45.23 (SD = 6.007. N = 22). For the teachers who had a dedicated technology integration class and whose instructors infused technology across the methods courses, the mean was 47.25 (SD = 6.041, N = 67).

Table 3

Descriptive Statistics

Level of Technology Infusion	Mean	Standard Deviation	N
Class (Group 1)	47.97	5.829	37
Infusion (Group 2)	45.23	6.007	22
Class and Infusion (Group 3)	47.25	6.123	67
Total	47.11	6.041	126

Results

This section will outline the process employed in collecting and screening the data and present the results of the one-way ANOVA.

Data Screening

The survey data was collected using Qualtrics[XM], and was exported to SPSS. Data screening was conducted in SPSS, and respondents who did not complete the entire survey or who entered invalid responses were removed from the data file. A box and whisker plot was created to identify any outliers (Figure 1). One outlier was identified and removed before proceeding with further analysis.

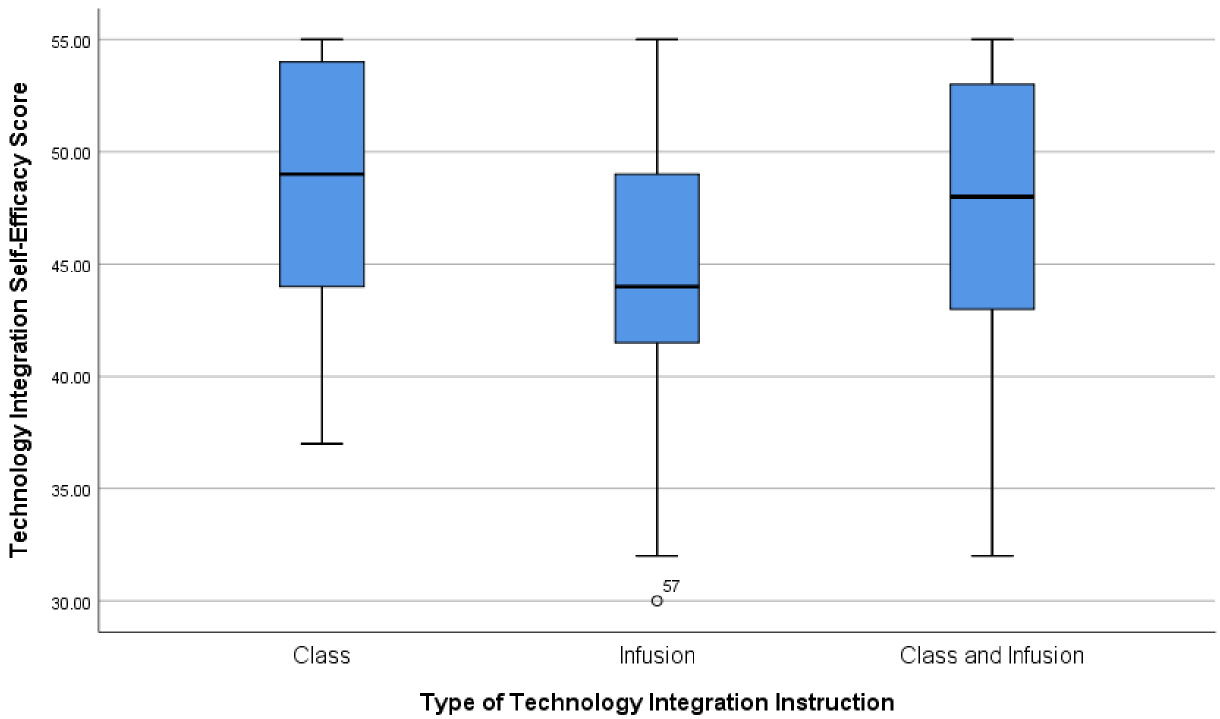

Figure 1: Box and Whisker Plot for Self-Efficacy by Level of Technology Infusion

Assumption Tests

A one-way ANOVA was used to test the hypothesis that there was no statistically significant difference in technology integration self-efficacy among beginning elementary school teachers by level of technology infusion in the undergraduate educator preparation program (dedicated technology course, technology infusion, or dedicated technology course plus technology infusion) as measured by the Technology and Teaching Efficacy Scale (TTES). The assumptions of a one-way ANOVA require that normality and homogeneity of variance exist. Dependent variables must be quantitative, independent variables must be categorical with two or more independent groups, and observations must be independent of each other between and within groups (Warner, 2013).

The normality of the data was examined using a Kolmogorov-Smirnov test (Table 4). The Kolmogorov-Smirnov test was used because the sample size was greater than 50 (N=126), and it is the preferred method of testing the normality of data (Green & Salkind, 2014).

Table 4

Kolmogorov-Smirnov Test of Normality of Data

Level of Technology Infusion	Kolmogorov-Smirnov[a]		
	Statistic	df	*p*
Class	0.122	37	0.176
Infusion	0.104	22	.200*
Class and Infusion	0.124	67	0.012

There was a violation of the test of normality found with the Class and Infusion group ($p < 0.05$). The ANOVA is robust to violations of the assumption of normality. Additionally, the skewness (-1.618) and kurtosis (-1.106) were both within the acceptable range. A visual examination of the frequency histograms in Figure 2 showed that the distribution shapes are close enough to normal shape (Warner, 2013). Based on these three factors, the decision was made to continue with the ANOVA.

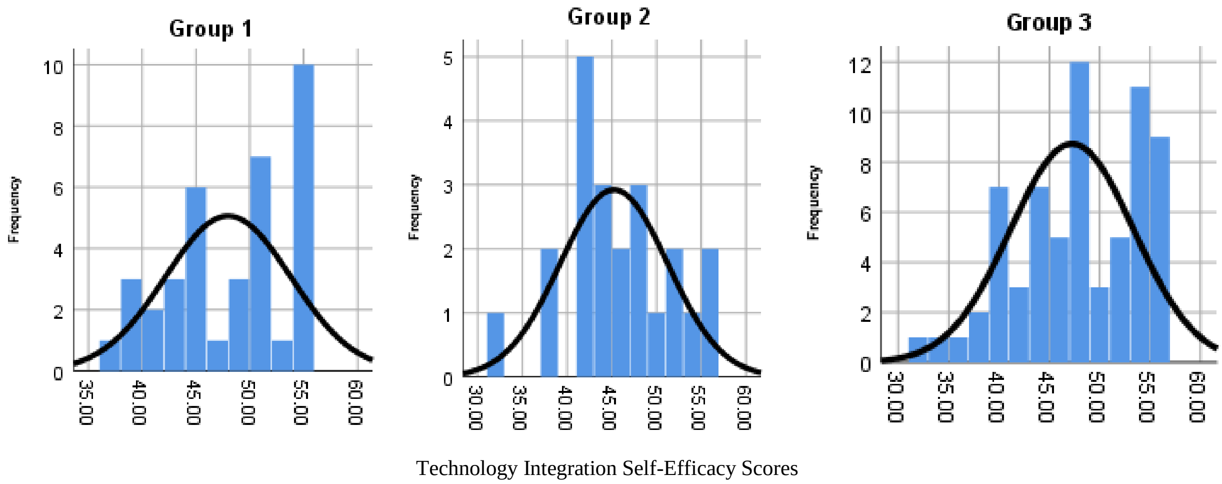

Figure 2. Frequency Histogram for Self-Efficacy Scores

Levene’s Test for Homogeneity of Variance was used to check for violations of the assumption of equality of variances (Table 5). The results of the test F(2, 123 = 0.051, p = .951) indicate that the test of homogeneity of variances was satisfied (p > .05).

Table 5

Levene’s Test of Equality of Variances

		Levene Statistic	df1	df2	*p*
Total Technology Self-Efficacy Score	Based on Mean	.025	2	124	.976
	Based on Median	.037	2	124	.964
	Based on Median and with adjusted df	.037	2	120.272	.964
	Based on trimmed mean	.032	2	124	.969

Results for the Null Hypothesis

A one-way ANOVA was used to determine if the hypothesis that there was no difference in technology self-efficacy scores among beginning teachers based on the level of technology integration instruction received in the four-year undergraduate teacher education program should be accepted. Table 6, One-way ANOVA for Technology Integration Self-Efficacy Scores, depicts the results from the one-way ANOVA that was conducted.

Table 6

One-way ANOVA for Technology Integration Self-Efficacy Scores

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	106.921	2	53.461	1.476	.233
Within Groups	4455.523	123	36.224		
Total	4562.444	125			

The results indicate that the null hypothesis should not be rejected at the 95% confidence level, where $F(2, 123) = 1.476$, $p = 0.233$, $\eta^2 = .023$. The partial eta squared, $\eta^2 = .023$, indicates that 2.3% of the teachers' total technology self-efficacy scores could be explained by the level of technology infusion in the undergraduate teacher education program, which is a medium effect. As the null hypothesis was not rejected, there were no follow up tests conducted.

Summary

This chapter described the procedures used in organizing and analyzing the data used in the study, as well as the results of those analyses. There were no significant differences found in the beginning teachers' total technology integration self-efficacy scores based on the level of technology infusion in their undergraduate teacher education programs (dedicated technology integration course, technology integration instruction infused across methods courses, or both a dedicated technology integration course and technology integration instruction infused across methods courses). Chapter 5 will provide further discussion of the results of the data analyses.

CHAPTER FIVE: CONCLUSIONS

Overview

As required by the North Carolina State Board of Education (SBE), schools of education within the state are required to report how candidates are prepared to integrate technology upon entry into the classroom. The SBE is concerned that teachers are not ready to use technology to improve teaching and learning as soon as they enter the classroom. The previous chapter presented the results that were obtained from an analysis of the responses of 126 beginning teachers in a major school system in North Carolina. This chapter will discuss those results against the background of this study, as well as the implications for teacher preparation in North Carolina. The limitations of the study will be discussed, and the researcher will recommend areas for future research.

Discussion

This causal-comparative study was designed to determine if there was a statistically significant difference in the technology integration self-efficacy scores of beginning teachers in a large school system in the southeastern United States based on how technology integration instruction was structured in their four-year undergraduate teacher education programs. The study was conducted against the background of the North Carolina state legislature's push to ensure that new teachers enter the workforce prepared to utilize instructional technology effectively. Current research concludes that one of the main factors that determine how effectively teachers integrate instructional technology is their self-efficacy with technology integration (Yesilyurt, Ulas, & Akan, 2016). Self-efficacy is the extent to which people believe in their ability to accomplish specific tasks. The self-efficacy of beginning teachers as related to their technology integration correlates to how well beginning teachers think that they can use technology to improve student learning and solve classroom problems (Lemon & Garvis, 2016; Troesch & Bauer, 2017). The research further identifies the level of preparation teachers receive in their undergraduate teacher education programs as one of the main predictors of their self-efficacy with technology integration in the classroom. The aim of this study was to fill a gap in the literature by delving more deeply into the relationship between how technology integration instruction is structured in the undergraduate program, and the degree of confidence that teachers have once they enter the profession.

All colleges and universities in the state of North Carolina must present an Institution of Higher Education Performance Report (IHE Report) to the State Board of Education (SBE). The three structural categories of instruction that were uncovered by a review of the IHE Reports are a dedicated instructional technology integration course, instructional technology integration infused across the methods courses, and both a dedicated instructional technology integration course and instructional technology integration infused across the methods courses. A review of the current literature indicates that the options are the same across the nation (Foulger, Wetzel, & Buss, 2019). The research question for this study was developed using the three structural categories of technology integration instruction that emerged from the review of the IHE Reports: Is there a difference in technology integration self-efficacy scores among beginning elementary school teachers by level of technology infusion in the undergraduate teacher education program as measured by the Technology and Teaching Efficacy Scale (TTES)? There were three groups of participants: Group 1 – the program included only a dedicated technology course; Group 2 – the program consisted of technology integration instruction infused throughout the methods courses; and Group 3 - the program included a dedicated technology integration course as well as technology integration instruction infused throughout the methods courses.

The technology integration self-efficacy scores for 126 beginning teachers across all three groups were analyzed using a one-way analysis of variance (ANOVA) to determine whether to accept or reject the null hypothesis that there is no statistically significant difference in technology integration self-efficacy scores among beginning elementary school teachers by level of technology infusion in the undergraduate educator preparation program. The results of the ANOVA, as displayed in Table 6, indicated that the null hypothesis should not be rejected. Although not statistically significant, as illustrated in Table 3, there were differences in the beginning teachers' self-efficacy scores across the three groups, with Group 1 interestingly having the highest mean score (M = 47.97), followed by Group 3 (M = 47.23), and Group 2 (M = 45.23), and the partial eta squared, $\eta^2 = .023$, indicated that there was a medium effect of the teachers' technology self-efficacy scores as they relate to the level of technology infusion in the undergraduate teacher education program.

Buss et al. (2015) undertook a quantitative study to compare beginning teacher self-efficacy between teachers who took a dedicated technology integration course, and teachers who experienced technology integration infusion in their methods courses. The data from the quantitative study indicated that while both groups showed improvements in their confidence with technology integration, technological knowledge (TK) and technological pedagogical knowledge (TPK) improved more rapidly in the dedicated course group, while content knowledge (CK) and pedagogical knowledge (PK) improved more rapidly in the infusion group. Additionally, Buss et al. (2018) conducted a qualitative study that supported the findings from the quantitative study, as the qualitative data indicated that the teachers in the infusion group were less confident in their ability to use technology to independently learn new programs, or to resolve technological issues that could arise in the classroom.

The results from the studies conducted by Buss et al. are consistent with the findings in this study. Table 7 shows the means and standard deviations for select questions in this study by groups of the dependent variable, level of undergraduate teacher education technology integration instruction. The questions in Table 7 were the questions for which a one-way ANOVA of the means for each question and a Tukey post-hoc test identified a significant difference in the means of at least two groups (Questions 7, 8, and 10), and one question where the mean score for the infusion group was higher than the mean scores for the other two groups (Question 2). For Question 7, the Tukey test indicated that there was a significant difference in the means of the dedicated course group and the infusion group, $p = .026$. Question 7 addressed technological knowledge (TK). The results show that the dedicated class group was significantly more confident in their ability to use technology to solve classroom problems than both the infusion group and the combined group. Questions 8 and 10 pertained to technological pedagogical knowledge (TPK). In both instances, the dedicated class group scored significantly higher than the infusion group. Question 2 dealt with pedagogical knowledge (PK). As with the studies by studies by Buss et al., the infusion group scored significantly higher than the class group. The researchers posited that the areas of differences in each group were likely attributable to dedicated courses being typically taught by faculty with expertise in technology integration, whereas methods courses are typically taught by content area experts.

Table 7

Descriptive Statistics for Select Survey Questions

			N	Mean	Std. Deviation
Q2	I am able to incorporate technology into any classroom subject	Class	37	4.41	.725
		Infusion	22	4.64	.581
		Class and Infusion	67	4.49	.612
		Total	126	4.49	.642
Q7	I am able to use technology to solve many classroom problems	Class	37	4.14	.887
		Infusion	22	3.50	1.012
		Class and Infusion	67	4.06	.868
		Total	126	3.98	.921
Q8	My students can think better because of my use of technology in the classroom	Class	37	4.11	.774
		Infusion	22	3.55	1.011
		Class and Infusion	67	3.94	.868
		Total	126	3.92	.882
Q10	My students retain more because I incorporate technology into their learning activities	Class	37	4.30	.740
		Infusion	22	3.68	.945
		Class and Infusion	67	4.09	.933
		Total	126	4.08	.900

The findings from all three studies stand in contrast to research that has concluded that dedicated technology integration courses, on their own, do not promote technology integration behaviors in beginning teachers (Nelson, Voithofer, & Cheng, 2019; Slykhuis et al., 2020). The mean score for the dedicated technology integration course group in this study (*M* = 47.97) was greater than the mean for all teachers (*M* = 47.11) and was high given that the total possible score was 55. Though surprisingly not the group with the highest mean, the teachers in the dedicated course and infusion group(*M* = 47.23) scored lower than the dedicated course group (*M* = 47.97) but higher than the infusion group (*M* = 45.23). This confirms that there is still great value to having a dedicated course within the teacher education program. While it is important for technology integration to be infused across the methods courses, preparing teachers to integrate technology can be a complex process, and the faculty who teach methods courses do not necessarily have the expertise required to effectively model content-specific technology integration (Estes & Dailey-Hebert, 2018; Foulger, Graziano, Schmidt-Crawford, & Slykhuis, 2017; Muilenburg, & Berge, 2015; Nelson et al., 2019; Tondeur et al., 2019). Indeed, teacher education programs must employ multiple strategies if they are to see major improvements in the technology integration self-efficacy of the new teachers they produce. There must be collaboration between faculty who teach educational technology and faculty who teach methods courses (Sun, Strobel, & Newby, 2017).

An examination of the mean technology integration self-efficacy scores per demographic group revealed some interesting information (Table 8).

Table 8

Mean Self-Efficacy Scores by Gender, Age, and Years of Teaching Experience

		Mean	N	Std. Deviation
Gender	Male	46.3333	24	5.88784
	Female	47.2941	102	6.09104
	Total	47.1111	126	6.04149
Age	18-24	46.5789	19	5.47028
	25-34	46.0370	54	6.26449
	35-44	47.7857	28	6.03298
	45-54	48.2941	17	6.14171
	55-64	50.7500	8	4.59036
	Total	47.1111	126	6.04149
Years of Teaching	Less than 1 year	45.7000	20	5.00631
	1 year	47.1765	17	6.91227
	2 years	47.0000	26	6.34980
	3 years	47.5873	63	6.03654
	Total	47.1111	126	6.04149

The mean for females (*M* = 47.29) was higher than the mean for males (*M* = 46.33). Typically, males report higher levels of technology self-efficacy than females (Hatlevik, Throndsen, Loi, & Gudmundsdottir, 2018; He & Freeman, 2016). Even more astonishing is that the mean score for beginning teachers in the 55-64 age range was the highest mean computed (*M* = 50.75) by age group. The 45-54 age group had the second highest mean (*M* = 48.29), followed by the 35-44 age group (M = 47.79). The 18-24 age group (*M* = 46.58) and the 25-34 age group (*M* = 46.04) reported the lowest levels of confidence in their ability to use technology in meaningful ways in the classroom. It would have been expected that the younger age groups would have been reported greater levels of comfort with using technology since they are digital natives. Digital natives, however, typically express high levels of technology skills but struggle with integration literacy. Although they are used to using technology in their everyday lives, they have yet to develop the skills needed to integrate technology in teaching and learning (Liu, 2016; Nijku et al., 2019; Ottenbreit-Leftwich, Liao, Sadik, & Ertmer, 2018; Wilson, Richman, Kimmons, Atkins, & Estes, 2018). Beginning teachers in the older age group are likely getting started on their second careers. Second career teachers typically have higher self-efficacy beliefs, because they have likely already acquired skills, knowledge, and resources in the workforce that provide them with confidence in their ability to adapt to a new environment, and to integrate technology in the classroom. Their maturity, motivation, and prior work experience are valued by school administrators (Hunter-Johnson, 2015; Nielson, 2016; Troesch & Bauer, 2020).

Not surprisingly, the mean score for beginning teachers with 3 years of teaching experience was the highest (*M* = 47.59). The mean scores for teachers with one year of experience (*M* = 47.18) and those with 2 years of experience (*M* = 47.00) were close, and not much lower than the mean score for teachers with 3 years in the classroom. However, the mean score for teachers in their first year on the job was well lower (*M* = 45.70). Research provides evidence that teacher effectiveness improves as teachers gain experience (Bowsher, Sparks, & Hoyer, 2018). Teachers benefit from having an opportunity to use technology in an authentic environment, and their instructional self-efficacy increases as they gain more experience. By their third year, teachers report improvements in their self-efficacy due to ideas obtained from self-exploration, social networks, access to peer mentors, and from trial and error with using technology in the classroom (Elstad & Christophersen, 2017; Foulger, Wetzel, & Buss, 2019; Ottenbreit-Leftwich et al., 2018).

Implications

A survey of beginning public school teachers across the United States indicated that new teachers felt less prepared to use computers in classroom instruction than for teaching the subject matter. Only 68% of the teachers responded that they felt sure of their abilities to use computers in their instructional practice (Wilson et al., 2018). The beginning teachers surveyed by this researcher had a high mean total technology integration self-efficacy score (*M* = 47.11), where the highest possible score was 55. There are several possible explanations for the difference in self-reporting by the beginning teachers in the different studies. It may be that the respondents to the survey in this study may have chosen to participate because their self-efficacy with technology integration was high. Teachers with lower self-efficacy may not have felt comfortable completing the survey. It may also be possible that the respondents felt the need to respond to the survey in a manner that is socially acceptable. Teachers know that they are expected to be able to use technology effectively in the classroom, and so they may have answered in a manner that reflected that expectation (Krause, 2017).

Conversely, if the new teachers in this study feel such confidence in their technology integration ability, either they are an exception to the nationwide trend where teachers do not feel adequately prepared by their undergraduate teacher education institutions, or they do not fully understand the extent of the expectations that the state and federal bodies have for them as teachers entering the profession. There may be a gap between what beginning teachers think they can do and what the state and federal governments believe they should be able to do, and teachers may not be fully aware of the frameworks such as the Digital Learning Competencies for Classroom Teachers, TPACK, TIMS, and UDL that delineate expectations for beginning teachers in terms of technology integration. In one study, new teachers stated that there was little mention of technology standards and digital citizenship in their programs (Becuwe et al., 2017; Nelson et al., 2019; Wilson et al., 2018). If teachers do not know the standards to which they are being held, they may have a false sense of efficacy. If such is the case, the implication is that teacher education programs need to better communicate the expectations that beginning teachers will face on their first day of the job, and prepare the beginning teachers to meet those expectations.

It is quite possible that the beginning teachers in this study are truly capable of using technology to engage students, promote learning, and solve classroom problems. The North Carolina State Department of Instruction (NCDPI) had robust technology integration professional development opportunities for all teachers, which included ongoing online professional learning and summer professional development workshops and conferences. On the local level, the school system provided first-year teachers with a retiree mentor, and provided teachers in years 1 to 3 with a building mentor. If beginning teachers still needed additional support, they were assigned a retiree mentor who worked with them one-on-one for up to 40 hours a week for 6 weeks. The support and professional development opportunities that beginning teachers received from the state and school system likely explained the difference in self-efficacy scores between teachers in their first year, and teachers who had at least a year of teaching experience. If the preparation the beginning teachers received from their teacher education programs was the reason for the high self-efficacy scores for first-year teachers, and if the beginning teacher support and professional development that new teachers received from the state and the school system were the reason for the higher technology integration self-efficacy scores for teachers beyond the first year of teaching, the implication is that perhaps the system is not broken. Schools of Education in the state may be doing a good job of preparing technologically capable educators, with the state and local school system building on that foundation. Schools of Education would, in such a case, need to ensure that state legislature is made to understand that technology is transient, and that pre-service preparation and in-service professional development are not mutually exclusive. Rather, they are both necessary phases in the growth and development of effective teachers.

The most meaningful implication of this study can be found in the comparison of the mean technology integration self-efficacy scores by undergraduate teacher education program type. The current research compares only the dedicated course model and the infusion model of technology integration instruction in teacher education. The findings in this study are contrary to the findings of past research that concluded that teachers whose teacher education programs involved technology infusion in the methods courses were better prepared to use technology in the classroom than teachers whose programs utilized a stand-alone technology course. Technological, pedagogical, content knowledge (TPACK) significantly influences new teachers' technology self-efficacy (Joo, Park, & Lim, 2018). Although the stand-alone course may not create the impact on beginning teachers' TPACK that is necessary for them to enter the workforce fully prepared to effectively use technology in their teaching and learning, neither does the infusion approach. However, in a mixed-methods study, Mouza et al. (2014) compared the pre-post scores of pre-service elementary education teacher education candidates on a TPACK survey, as well as their reflections and responses to open-ended questions. The mixed-methods study found that the preservice teachers exhibited gains in all constructs of TPACK and were able to apply their training during their field experiences and student teaching. If beginning teachers who are prepared via the dedicated technology course demonstrate greater growth in technological knowledge (TK) and technological pedagogical knowledge (TPK), and beginning teachers who are prepared vial the infusion approach demonstrate greater growth in content knowledge (CK) and pedagogical knowledge (PK), it stands to reason that both methods of preparation are instrumental in developing technology integration self-efficacy in beginning teachers (Mouza et al., 2014, Trainin, Friedrich, & Deng, 2018). Researchers should include the combined preparation method in their studies instead of focusing on just the stand-alone course versus the infusion approach. Schools of Education also need to reconsider the idea of removing the dedicated course and replacing it with infusion in the methods courses. They should instead consider the potential for developing beginning teachers' TPACK using the combined approach. Teacher education programs should also be purposeful about the placement of the educational technology course. The technology course should not be so early in the program that students experience a disconnect between what is learned in the course, and what is subsequently taught in the methods courses (Sun, Strobel, & Newby, 2017).

Limitations

There were several limitations that were considered for this study. One limitation is that the sample was restricted to one school system in one area of the country. It would, therefore, be difficult to make generalizations regarding beginning teachers in other school systems in the state, region, or country based on the results from such a localized group of participants. Additionally, the support that the beginning teachers in this study received from the district and the state was not necessarily the same level of support that other beginning teachers outside of the district and state received. When teachers feel that their professional growth is supported and encouraged, their self-efficacy is positively affected (Hatlevik & Hatlevik, 2018). The study did not compare the self-efficacy scores of the beginning teachers who graduated from teacher education programs in North Carolina and those who graduated from out-of-state programs. It is worth noting that participants volunteered for the study, which may have resulted in biases in the results. Participants may have chosen to complete the survey because they had high technology integration self-efficacy. Respondents also self-reported the method that their institutions used to provide instruction on technology integration, and those self-reported descriptors were used for this study. The self-reporting may have been subject to the respondents' memory and perception.

The primary reason for selecting beginning teachers for this study was so that their self-efficacy would not have been influenced by other factors such as professional development and experience. However, a study of just first-year beginning teachers may have been more impactful as it is difficult to say how much of a role professional development and years of experience played in the differences in mean self-efficacy scores of the first-year teachers and teachers who have been in the classroom for more than a year. By their third year, many teachers have improved their technology integration skills through trial and error, self-exploration, professional development, social networking, professional learning networks, and access to mentors (Foulger et al., 2019; Ottenbreit-Leftwich et al., 2018).

Beginning teachers in this study may have had different definitions of technology as it relates to its use in the classroom. No definition or examples of technology were provided, so the participants were free to use their own definitions. Some teachers may have had only a basic concept of technology (such as computers and smartboards) while others may have a more developed understanding of instructional technology and its many facets (including instructional design, classroom management, productivity software, web and mobile applications, gaming, assessment, assistive technologies, student-centered instruction, and differentiation) (Ottenbreit-Leftwich, Ertmer, & Tondeur, 2015). There may also have been differences in what was taught in the teacher education programs, both in terms of the dedicated class and in terms of infusion.

Recommendations for Future Research

Based on the information that has emerged from this study, the following are recommendations for future research to aid in further understanding how best to prepare pre-service teachers for instructional technology integration in their future classrooms:

1. Replicate this study in school systems across the state to see if a pattern develops. The results would help to inform the state legislature regarding the effectiveness of teacher education programs across the state, and would inform those programs of the most effective method for producing candidates who are prepared to use technology effectively in schools.
2. Conduct qualitative research regarding teacher technology self-efficacy in North Carolina. Qualitative responses would be useful in addressing many of the

limitations of this study. It would provide a better understanding of the instruction the beginning teachers received in the teacher education program, clarify and codify what constitutes technology integration, and aid in determining how much of the beginning teachers' self-efficacy is attributable to them having graduated from the program.

3. Conduct further research on beginning teacher self-efficacy after completing a program that used both a dedicated technology integration course and technology infusion across the methods courses (including student teaching). Schools of Education in North Carolina are revisiting their programs, and, in many cases, they are reducing the number of hours required to earn a degree. The technology integration course is often on the chopping block. Research on this topic would ensure that the Schools of Education make decisions that are in the best interest of their teacher education candidates, and the students they will teach.
4. A longitudinal study of beginning teachers as they progress through the first three years of their teaching careers, to determine if the improvements in self-efficacy scores (and the factors that result in those improvements) are consistent with the higher scores for teachers beyond the first year.
5. Research that categorizes the level of technology integration instruction that a teacher education provides based on reporting from the institution and a survey of course syllabi and assessments. A study that involves participants who graduated from institutions that have been categorized by the researchers (rather than by respondents' self-reporting) would yield valuable information.

REFERENCES

Admiraal, W., van Vugt, F., Kranenburg, F., Koster, B., Smit, B., Weijers, S., & Lockhorst, D. (2017). Preparing pre-service teachers to integrate technology into K-12 instruction: evaluation of a technology-infused approach. *Technology, Pedagogy and Education, 26*(1), 105-120. DOI:10.1080/1475939X.2016.1163283

Aflalo, E., Zana, L., & Huri. T. (2017). The interactive whiteboard in primary school science interaction. *Interactive Learning Environments, 26*(4), 525-538.

Amirault, R. J. (2015). Technology transience and the challenges it poses to higher education. *Quarterly Review of Distance Education, 16*(2).

Bakir, N. (2016). Technology and teacher education: A brief glimpse of the research and practice that have shaped the field. *Tech Trends: For Leaders in Education & Training, 60*(1), 21-29. DOI 10.1007/s11528-015-0013-4

Ball, B. (2017). *In dwindling days of session, Senate looks to privatize teacher prep. NC Policy Watch*. Retrieved from http://pulse.ncpolicywatch.org/2017/06/28/dwindling-days-session-senate-looks-privatize-teacher-prep/#sthash.IufyVQPx.dpbs

Becuwe, H., Robbin, N. P., Tondeur, J., Thys, J., Castelen, E., & Voogt, J. (2017). Conditions for the successful implementation of teacher educator design teams for ICT integration: A Delphi study. *Australasian Journal of Educational Technology, 33*(2), 159-172.

Belland, B. R., Walker, A. E., Kim, N. J., & Lefler, M. (2016). Synthesizing results from empirical research on computer-based scaffolding in STEM education: A meta-analysis. *Review of Educational Research, 87*(2), 309-344.

Benton-Borghi, B. H. (2013). A universally designed for learning (UDL) infused technological pedagogical content knowledge (TPACK) practitioners' model essential for teacher preparation in the 21st century. *Journal of Educational Computing Research, 48*(2), 245-265.

Bingimlas, K. A. (2017). Learning and teaching with web 2.0 applications in Saudi k-12 schools. *The Turkish Online Journal of Educational Technology, 16*(3), 100-115.

Bowsher, A., Sparks, D., & Hoyer, K. M. (2018). *Preparation and support for teachers in public schools: Reflections on the first year of teaching*. National Center for Education Statistics. Retrieved from https://nces.ed.gov/pubs2018/2018143.pdf

Bragg, D. D. (2017). Transfer matters: Forward to the special issue on transfer. *Community College Review, 45*(4), 267-272.

Bullock, S. M. (2013). Using digital technologies to support Self-Directed Learning for preservice teacher education. *Curriculum Journal*, *24*(1), 103-120. DOI:10.1080/09585176.2012.744695

Buss, R. R., Wetzel, K., Foulger, T. S., & Lindsey, L. (2015). Preparing teachers to integrate technology into K-12 instruction: Comparing a stand-alone technology course with a technology-infused approach. *Journal of Digital Learning in Teacher Education, 31*(4), 160-172.

Buss, R. R., Foulger, T. S., Wetzel, K., & Lindsey, L. (2018). Preparing teachers to integrate technology into K-12 instruction II: Examining the effects of technology-infused methods courses and student teaching. *Journal of Digital Learning in Teacher Education, 34*(3), 134-150.

Cahill, M., & Bigheart, J. (2016). What can librarians learn from Elmo, Sid, and Dora? Applying the principles of educational television to storytime. *Knowledge Quest, 44*(3), 49-57.

Cain, V. (2017). From Sesame Street to prime time school television: Educational media in the wake of the Coleman Report. *History of Education Quarterly, 57*(4), 590–601.

Cam, S. S., Yarar, G., Toraman, C., & Erdamar, G.K. (2016). The effects of gender on the attitudes towards computer-assisted instruction: A meta-analysis. *Journal of Education and Training Studies, 4*(5), 250-261.

Carroll, J., Diaz, A., Meiklejohn, J., Newcomb, M., & Adkins, B. (2013). Collaboration and competition on a wiki: The praxis on online social learning to improve academic writing and research in undergraduate students. *Australasian Journal of Educational Technology, 29*(4), 513-525.

Cennamo, K. S., Ross. J. D., & Ertmer, P. A. (2019). *Technology Integration for meaningful classroom use: A standards-based approach* (3rd ed.). Boston, MA: Cengage.

Center for Applied Special Technology. (n.d.). *About universal design for learning*. Retrieved from http://www.cast.org/our-work/about-udl.html#.XrWiFqhKiUk

Christensen, R. (2002). Effects of technology integration education on the attitudes of teachers and students. *Journal of Research on Technology in Education, 34*(4), 411-433. DOI: 10.1080/15391523.2002.10782359

Cimermanova, I. (2018). The effect of learning styles on academic achievement in different forms of teaching. *International Journal of Instruction, 11*(3), 219-232.

Clements, D. H., & Sarama, J. (2016). Math, Science, and Technology in the early grades. *Future of Children, 26*(2), 75-94.

Conner, L., & Sliwka, A. (2014). Implications of research on effective learning environments for initial teacher education. *European Journal of Education, 49*(2), 165-177. DOI: 10.1111/ejed.12081

Cook, S. C., Rao, K., & Collins, L. (2017). Self-monitoring interventions for students with EBD: Applying UDL to a research-based practice. *Beyond Behavior, 26*(1), 19-27. DOI:

Council for the Accreditation of Educator Preparation. (2016). *CAEP Accreditation Handbook.* Washington, DC. Retrieved from http://caepnet.org/~/media/CAEP%20Accreditation%20Handbook_March%202016.pdf?la=en

Council of Chief State School Officers. (2011*). Interstate Teacher Assessment and Support Consortium (InTASC) model core teaching standards: A resource for state dialogue*. Washington, DC.

Crompton, H., Burke, D., & Gregory, K. H. (2017). The use of mobile learning in PK-12 education: A systematic review. *Computers & Education, 110*, 51-63.

Dalby, D., & Swan, M. (2019). Using digital technology to enhance formative assessment in mathematics classrooms. *British Journal of Educational Technology, 50*(2), 832-845.

Daun-Barnett, N., & Escalante, S. (2014). Local influences of community college baccalaureate legislation on nursing and teaching degree production in Florida. *Community College Journal of Research and Practice, 38*(11), 1030 – 1043.

Davidovich, N., & Yavich, R., (2017). The effect of SmartBoards on the cognition and motivation of students. *Higher Education Studies, 7*(1), 60-68.

Dawson, E. (2017). Social justice and out-of-school science learning: Exploring equity in science television, science clubs, and maker spaces. *Science Education, 101*, 539-547.

DiDomenico, J. (2017). Effective integration of music in the elementary school classroom. *Inquiry in Education, 9*(2), 1-18.

Elstad, E., & Christophersen, K. (2017). Perceptions of digital competency among student teachers: Contributing to the development of student teachers' instructional self-efficacy in technology-rich classrooms. *Education Sciences, 7*(1), 27-41.

Estes, J. S., & Dailey-Hebert, A. (2018*). Modeling technology integration in teacher preparation programs*. In J. Keengwe (Ed.), Handbook of research on pedagogical models for next-generation teaching and learning (pp. 82-97). IGI Global.

Eun, B. (2019). Adopting a stance: Bandura and Vygotsky on professional development. *Research in Education, 105*(1), 74-88.

Eyvind, E., & Christophersen, K. (2017). Perceptions of digital competency among student teachers: Contributing to the development of student teaches' instructional self-efficacy in technology-rich classrooms. *Education Sciences, 7*(1), 27-41.

Farr, F., & Murray, L. (Eds.). (2016). *The Routledge handbook of language learning and technology*. New York, NY: Routledge.

Florida Department of State. (2015). *Approval of Educator preparation programs (Final)*. Retrieved from https://www.flrules.org/gateway/RuleNo.asp?title=EDUCATOR%20STANDARDS,%20PREPARATION%20AND%20PERFORMANCE&ID=6A-5.066

Foulger, T. S., Graziano, K. J., Schmidt-Crawford, D. A., & Slykhuis, D. A. (2017). Teacher Educator Technology Competencies. *Journal of Technology and Teacher Education, 25*(4), 413-448.

Foulger, T. S., Wetzel, K., & Buss, R. (2019). Moving toward a technology infusion approach: Considerations for teacher preparation programs. *Journal of Digital Learning in Teacher Education, 35*(2), 79-91.

Friday Institute for Educational Innovation. (2015). North Carolina Digital Learning Plan. Retrieved from https://ncdli.fi.ncsu.edu/dlplan/docs/dl-plan-summary.pdf

Gall, M. D., Gall, J. P., & Borg, W. R. (2006). *Educational research: An introduction* (8th ed.). New York, NY: Allyn & Bacon.

Gentry, J. E., Baker, C., Thomas, B. D., Whitfield, C., & Garcia, L. (2014). Transforming technology integration: An instrument to measure educator's self-efficacy for modeling 21st-century skills. *National Teacher Education Journal, 7*(3), 31-38.

Grant, M. M., Tamim, S., Brown, D. B., Sweeney, J. P., Ferguson, F. K., & Jones, L. B. (2015). Teaching and learning with mobile computing devices: Case study in K-12 classrooms. *Tech Trends, 59*(4), 32-45.

Green, S. B., & Salkind, N. J. (2014). *Using SPSS for Windows and Macintosh: Analyzing and understanding data* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Groff, G. S. (2018). The potentials of game-based environments for integrated, immersive learning data. *European Journal of Education Research, Development and Policy, 53*(2), 188-201.

Han, I., Shin, W. S., & Ko, Y. (2017). The effect of student teaching experience and teacher beliefs on pre-service teachers' self-efficacy and intention to use technology in teaching. *Teachers and Teaching, 23*(7), 829-842.

Harris, C. J. (2016). The effective integration of technology into schools' curriculum. *Distance Learning*, 13(2), 27-37.

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types. *Journal of Research on Technology in Education, 41*(4), 393-416.

Hatlevik, I., & Hatlevik, O. E. (2018). Examining the relationship between teachers' ICT self-efficacy for educational purposes, collegial collaboration, lack of facilitation and the use of ICT in teaching practice. *Frontiers in Psychology, 9*, 935+.

Hatlevik, I., Throndsen, I., Loi. M., & Gudmundsodottir, G. B. (2018). Students' ICT self-efficacy and computer information literacy: Determinants and relationships. *Computers & Education*, *118*, 107-119.

Haynes, J. C., Robinson, J. S., Edwards, M. C., & Key, J. P. (2012). Assessing the effect of using a science-enhanced curriculum to improve agriculture students' science scores: A causal comparative study. *Journal of Agricultural Education, 53*(2), 15-27. DOI:10.5032/jae.2012.02015

He, J., & Freeman, L. A. (2016). Are men more technology-oriented than women? The role of gender on the development of general computer self-efficacy of college students. *Journal of Information Systems Education, 21*(2), 203-212.

Hosch, W. L. (2018). Web 2.0. In *Encyclopaedia Britannica online*. Retrieved from https://www.britannica.com/topic/Web-20

Hosokawa, R., & Katsura, T. (2018). Association between mobile technology use and child adjustment in early elementary school age. *PLoS One*, *13*(12).

Hsu, P. (2016). Examining current beliefs, practices and barriers about technology integration: A case study. *TechTrends, 60*, 30-40.

Hu, H., Oslick, M. E., & Wake, D. (2017). Innovative web 2.0 technologies to support struggling readers. *Journal of Educational Technology Development & Exchange, 10*(1), 55-71.

Hunter-Johnson, Y. (2015). Demystifying the mystery of second career teachers' motivation to teach. *The Qualitative Report, 20*(8), 1359+

Hur, J. W., Shannon, D., & Wolf, S. (2016). An investigation of relationships between internal and external factors affecting technology integration in classrooms. *Journal of Digital Learning in Teacher Education, 32*(3), 105-114. DOI: 10.1080/21532974.2016.1169959

Instefjord, E., & Munthe, E. (2016). Preparing pre-service teachers to integrate technology: An analysis of the emphasis on digital competence in teacher education curricula. *European Journal of Teacher Education, 39*(1), 77-93. DOI:10.1080/02619768.2015.1100602

Ipek, I. & Ziatdinov, R. (2017). New approaches and emerging trends in educational technology for learning and teaching in academia and industry. *European Journal of Contemporary Education, 6*(3), 381-389. DOI: 10.13187/ejced.2017.3.381

Janssen, N., & Lazonder, A. W. (2016). Supporting pre-service teachers in designing technology-infused lesson plans. *Journal of Computer Assisted Learning, 32*(5), 456-467.

Johns, K. (2015). Engaging and assessing students with technology: A review of Kahoot! *Delta Kappa Gamma Bulletin, 81*(4), 89-91.

Jones, E. M., Baek, J., & Want, J. D. (2017). Exploring pre-service physical education teacher technology use during student teaching. *Journal of Teaching in Physical Education, 36*(2), 173-184.

Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK, teacher self-efficacy, and technology acceptance model. *Educational Technology & Society, 21*(3), 48-59.

Kirschner, P. A., & De Bruyckere, P. (2017). The myths of the digital native and the multitasker. *Teaching and Teacher Education*, *67*, 135-142.

Krause, J. M. (2017). Physical education student teachers' technology integration self-efficacy. *The Physical Educator*, *74*(3), 476+.

Lakhana, A. (2014). What is educational technology? An inquiry into the meaning, use, and reciprocity of technology. *Canadian Journal of Learning and Technology, 40*(3). Retrieved from https://eric.ed.gov/?id=EJ1038412.

Lamb, A. (2014). Apps and websites: An eclectic mix for educators and students. *Teacher Librarian, 42*(2), 50-52.

Lehmann, J. A. M., & Seufert, T. (2018). Can music foster learning: Effects of different text modalities on learning and information retrieval. *Frontiers in Psychology, 8*, 2305.

Lemon, N., & Garvis, S. (2016). Pre-service teacher self-efficacy in digital technology. *Teachers and Teaching, 22*(3), 387-408.

Li, K., Li, Y., & Franklin T. (2016). Preservice teachers' intention to adopt technology in their future classrooms. *Journal of Educational Computing Research, 54*(7), 946-966.

Liu, P. (2016). Technology integration in elementary classrooms: Teaching practices of student teachers. *Australian Journal of Teacher Education, 41*(3).

Martin, F. & Carr, M. L. (2015). An exploratory study on K-12 teachers' use of technology and multimedia in the classroom. *Journal of Educational Technology, 12*(1), 7-14.

Mastnak, W. (2016). Perinatal music therapy and antenatal music classes: Principles, mechanisms, and benefits. *The Journal of Perinatal Education, 25*(3), 184-192.

Matoti S, Junqueira K, & Odora R. (2013). Assessing the teaching efficacy beliefs of teacher trainees: A comparison of two institutions of Higher Learning in South Africa. *Africa Education Review, 10*(4), 634-653.

Mayo, N. B., Kajs, L. T., & Tanguma, J. (2005). A longitudinal study of technology training to prepare future teachers. *Education Research Quarterly, 29*(1), 3-13.

McKnight, K., O'Malley, K., Ruzic, R., Horsley, M. K., Franey, J. J., & Bassett, K. (2016). Teaching in a digital age: How educators use technology to improve student learning. *Journal of Research on Technology in Education, 48*(3), 194-211. DOI: 10.1080/15391523.2016.1175856

McManis, M. H., & McManis, L.D. (2016). Using a touch-based, computer-assisted learning system to promote literacy and math skills for low-income preschoolers. *Journal of Information Technology Education: Research, 15*, 409-429.

Millman, N. B., Carlson-Bancroft, A., & Vanden Boogart, A. (2014). Examining differentiation and utilization of iPads across content areas in an independent, PreK-4th grade elementary school. *Computers in the Schools, 31*(3), 119-133.

Mitten, C., Jacobbe, T., & Jacobbe, E. (2017). What do they understand? Using technology to facilitate formative assessment. *Australian Primary Mathematics Classroom, 22*(1), 9-12.

Moriarty, B. (2014). Research design and the predictive power of measures of self-efficacy. *Issues in Educational Research*, *24*(1), 55-66.

Mouza, C., Karchmer-Klein, R., Nandakumar, R., Ozden, S. Y., & Hu, L. (2014). Investigating the impact of an integrated approach to the development of preservice teachers' technological pedagogical content knowledge (TPACK). *Computers & Education, 71*, 206-221.

Muilenburg, L. Y., & Berge, Z. L. (2015). Revisiting teacher preparation: Responding to technology transience in the educational setting. *Quarterly Review of Distance Education, 16*(2), 93+

Nelson, M. J., Voithofer, R., & Cheng, S. (2018). Mediating factors that influence the technology integration practices of teacher educators. *Computers & Education, 128,* 330-344.

Nielson, A. (2016). Second career teachers and (mis)recognitions of professional identities. *School Leadership & Management, 36*(2), 221-245.

Njiku, J., Maniraho, J.F., & Mutarutinya, V. (2019). Understanding teachers' attitude towards computer technology integration in education: A review of literature. *Education and Information Technologies, 24*, 3041-3052.

North Carolina Department of Public Instruction. (2016). *EPP Performance*. Retrieved from https://www.dpi.nc.gov/educators/educator-preparation/epp-performance

North Carolina Department of Public Instruction. (n.d). *NC Digital Learning Competencies for Classroom Teachers*. Retrieved from https://www.dpi.nc.gov/districts-schools/districts-schools-support/digital-teaching-and-learning/digital-learning-nc

North Carolina School Boards Association. (2017). *NCSBA Legislative Update – May 2017.* Retrieved from http://www.ncsba.org/2017/05/3149/

Nyland, R. (2018). A Review of Tools and Techniques for Data-Enabled Formative Assessment. *Journal of Educational Technology Systems, 46*(4), 505–526.

O'Leary, M., Scully, D., Karakolidis, A., & Pitsia, V. (2018). The state-of-the-art in digital technology-based assessment. *European Journal of Education Research, Development and Policy, 53*(2), 160-175.

Oliver, K., & Townsend, L. (2013). Preparing teachers for technology integration: Programs, competencies, and factors from the literature. *National Teacher Education Journal, 6*(3), 41-60. Retrieved from http://files.eric.ed.gov/fulltext/ED559715.pdf

Ormanci, U., Cepni, S., Deveci, I., & Aydin, O. (2015). A thematic review of interactive whiteboard use in education: Rationales, purposes, methods and general knowledge. *Journal of Science Education & Technology, 24*(5), 532-548.

Ottenbreit-Leftwich, A. T., Ertmer, P. A., & Tondeur, J. (2015). Interpretation of research on technology integration in teacher education in the USA: Preparation and current practices. In P. Smeyers, D. Bridges, N. C. Burbules, & M. Griffiths (Eds.), *International handbook of interpretation in educational research* (pp. 1239-1262). Springer.

Ottenbreit-Leftwich, A., Liao, J. Y. C., Sadik, O., & Ertmer, P. (2018). Evolution of teachers' technology integration knowledge, beliefs, and practices: How can we support beginning teachers using technology? *Journal of Research on Technology in Education, 50*(4), 282-304.

Outhwaite, L. A., & Faulder, M. (2019). Raising early achievement in math with interactive apps: A randomized control trial. *Journal of Educational Psychology, 111*(2). 284-298.

Overbaugh, R. C., Lu, R., & Diacopoulos, M. (2015). Changes in teachers' attitudes toward instructional technology attributed to completing the ISTE NETS*T Certificate of Proficiency Capstone Program. *Computers in the Schools, 32*(3-4), 240-259.

Park, T. J., Tandbert, D. A., Shim, H., Hu, S., & Herrington, C. D. (2016). Community college teacher education baccalaureate programs: Early evidence yields mixed results. *Educational Policy*. Retrieved from http://journals.sagepub.com.ezproxy.liberty.edu/doi/pdf/10.1177/0895904816682317

Parong, J., & Mayer, R.E. (2018). Learning science in immersive virtual reality. *Journal of Educational Psychology*, *110*(6), 785-797.

Polly, D. (2014). Elementary school teachers’ use of technology during math teaching. *Computers in the Schools*, *31*, 271-292.

Petrilli, M. J. (2016). Children, be quiet and watch your lesson. *Education Next*, *16*(3), 86–87.

Pitchford, N. J., Chigeda, A., & Huber, P. J. (2019). Interactive apps prevent gender discrepancies in early-grade mathematics in a low-income country in sub-Sahara Africa. *Developmental Science, 33*(5).

Pittman, T., & Gaines, T. (2015). Technology integration in third, fourth and fifth-grade classrooms in a Florida school district. *Educational Technology Research & Development, 63*(4), 539-554.

Public Schools of North Carolina, State Board of Education. (2016*). Beginning Teacher Support Program Handbook: A Guide for NC Beginning Teacher Coordinators*. Retrieved from https://1.cdn.edl.io/gOVg2XON77gvHXduUweHpy2l3IW0szeLisIShQAU8mi7nKvB.pdf

Reeves, J. L., Gunter, G. A. Lacey, C. (2017). Mobile learning in pre-kindergarten: Using student feedback to inform practice. *Educational Technology & Society*, *20*(1), 37-44.

Robinson, C. (2018). Technology tools for paperless formative assessment. *Science Scope, 41*(5), 24-27.

Sadaf, A. S., Newby, T., & Ertmer, P. (2016). An investigation of the factors that influence preservice teachers' intentions and integration of Web 2.0 tools. *Educational Technology Research & Development*, *64*(1), 37-64.

Savage, M. (2016). Mapping pre-service teachers’ evolving information and communication technology pedagogy. *Technology, Pedagogy and Education*, *25*(5), 533-554. DOI:10.1080/1475939X.2016.1148070

Sawchuk, S. (2015). Steep drops seen in teacher-prep enrollment numbers. *The Education Digest, 80*(7), 9-12.

Schwarz, G. (2016). CAEP and the decline of curriculum and teaching in an age of techne. *Curriculum and Teaching Dialogue, 18(*1/2), 41-54.

Scott, L. A., Thoma, C.A., Puglia, L., Temple, P., & D’Aguilar, A. (2017). Implementing a UDL framework: A study of current personnel preparation practices. *Intellectual and Developmental Disabilities, 55*(1), 25-36.

Slykhuis, D. A., Foulger, T. S., Graziano, K. J., Hofer, M., Lee, J. K., & Schmidt-Crawford, D. A. (2020). TETC Professional Development: An online program for teacher education. In D. Schmidt-Crawford (Ed.), *Proceedings for Information Technology & Teacher Education International Conference* (pp. 474-478). Retrieved from https://www.learntechlib.org/primary/p/215784/

Stover, K., Yearta, L., & Harris, C. (2016). Formative assessment in the digital age: Blogging with third graders. *The Reading Teacher, 69*(4), 377-381.

Sun, Y., Strobel, J., & Newby, T. J. (2017). The impact of student teaching experiences on pre-service teachers’ readiness for technology integration: A mixed methods study with growth curve modeling. *Education Technology, Research and Development, 65*(3), 597-629.

Tanguma, J., Underwood, D., & Mayo, N. (2004). *A validation study of the Technology and Teaching Efficacy Scale*. Presentation at the annual conference of the Southeast Educational Research Association, Dallas, TX.

Timmis, S., Broadfoot, P., Sutherland, R., & Oldfield, A. (2016). Rethinking assessment in a digital age: Opportunities, challenges and risks. *British Educational Research Journal, 42*(3), 454-476.

Tondeur, J., Roblin, N. P., van Braak, J., Voogt, J., & Prestridge, S. (2017). Preparing beginning teachers for technology in education: Ready for take-off? *Technology, Pedagogy, and Education, 26*(2), 157-177. DOI:10.1080/1475939X.2016.1193556

Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Teemu V., & Erkko S. (2019). Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. *British Journal of Educational Technology, 50*(3), 1189-1209.

Trainin, G., Friedrich, L., & Deng, Q. (2018). The impact of a teacher education program redesign on technology integration in elementary preservice teachers. *Contemporary Issues in Technology and Teacher Education, 18*(4).

Troesch, L. M., & Bauer, C. E. (2017). Second career teachers: Job satisfaction, stress, and the role of self-efficacy. *Teaching and Teacher Education, 67*, 389-398.

Troesch, L. M., & Bauer, C. E. (2020). Is teaching less challenging for career switchers? First and second career teachers’ appraisal of professional challenges and their intention to leave teaching. *Frontiers in Psychology, 10*, 3067.

Trotti, J., Hendricks, R., & Bledsoe, C. (2017). Emergent literacy development and computer-assisted instruction. *SRATE Journal, 25*(1), 30-39.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education, 17*, 783-805.

Uerz, D., Volman, M., & Kral, M. (2018). Teacher educators' competences in fostering student teachers' proficiency in teaching and learning with technology: An overview of relevant research literature. *Teaching and Teacher Education 70*, 12-23.

U.S. Department of Education, Office of Educational Technology. (2017). *Reimagining the role of technology in education: 2017 National Education Plan Update*. Retrieved from https://tech.ed.gov/files/2017/01/NETP17.pdf

Velasco, R. C. (2018). Infusing classrooms with web 2.0 technologies: The idea of using web 2.0 technologies in educational settings should be embraced. *Technology and Engineering Teacher, 77*(6), 36-39.

Wachter Morris, C. A., & Wester, K. L. (2018). *Making research relevant: Applied research designs for the mental health practitioner*. New York, NY: Routledge.

Warner, R. M. (2013). *Applied statistics: From bivariate through multivariate techniques* (2nd ed.). Thousand Oaks, CA: Sage Publications.

West-Puckett, S. (2016). Making classroom writing assessment more visible, equitable, and portable through digital badging. *Urbana, 79*(2), 127-151.

Willis, J. M. (2015). Examining technology and teaching efficacy of preservice teacher candidates: A deliberate course design model. *Current Issues in Education, 18*(3). Retrieved from https://cie.asu.edu/ojs/index.php/cieatasu/article/view/1385.

Wilson, E., Richman, L. J., Kimmons, R., Atkins, H. & Estes, J. (2018). Preparing teacher candidates for transformable digital teaching and learning experiences: Case studies from teacher preparation programs. In E. Langran & J. Borup (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 1776-1781). Association for the Advancement of Computing in Education.

Wilson, S. D. (2018). Implementing co-creation and multiple intelligence practices to transform the classroom experience. *Contemporary Issues in Education Research, 11*(4), 127-132.

Wood, E., Grant, A. K., Gottardo, A., Savage, R., & Evans, M. A. (2017). Software to promote young children's growth in literacy: A comparison of online and offline formats. *Early Childhood Education Journal, 45*, 207-217.

Yarbro, J., McKnight, K., Elliott, S., Kurz, A., & Wardlow, L. (2016). Digital instructional strategies and their role in classroom learning. *Journal of Research on Technology in Education, 48*(4), 274-289.

Yesilyurt, E., Ulas, A. H., & Akan, D. (2016). Teacher self-efficacy, academic self-efficacy, and computer self-efficacy as predictors of attitude toward applying computer-supported education. *Computers in Human Behavior, 64*, 591-601.

Young, J., Hamilton, C., & Cason, M. (2017). Interactive whiteboards in mathematics spaces: An examination of technology integration in an urban middle school. *Contemporary Educational Technology, 8*(4), 303-318.

Yu, W.W., & Okojie, M. (2017). Pedagogy and technology infusion. *The Journal of Research in Business Education, 58*(1), 62-74.

Zengin, Y. (2016). Investigating the use of the Khan Academy and mathematics software with a flipped classroom approach in mathematics teaching. *Educational Technology & Society*, *20*(2), 89-100.

Zhang, M., Trussell, R. P., Gallegos, B., & Asam, R. R. (2015). Using math apps for improving student learning: An exploratory study in an inclusive fourth grade classroom. *Tech Trends*, *59*(2), 32-39.

APPENDICES

Appendix A: Technology and Teaching Self-Efficacy Scale (TTES)

Dr. David G. Underwood and Dr. Jesús Tanguma

Removed to comply with copyright.

APPENDIX B: Permission to Use the TTES

Jesus Tanguma <jesus.tanguma@mail.waldenu.edu>
Tue 3/12/2019 7:08 PM
To: Johnson, Reeshemah

Reeshemah,

According to Dr. Willis, that scale was created by Dr. Underwood, and I. Thus, you have my permission to use it.

If there is anything else I may be able to help you, please let me know.

Have a blessed day,

JT

Johnson, Reeshemah
Fri 3/8/2019 8:16 PM
To: Jesus.tanguma@mail.waldenu.edu

Dear Dr. Tanguma:

My name is Reeshemah Johnson and I am a doctoral student in the School of Education at Liberty University. I am conducting research as part of the dissertation requirement for Doctor of Education degree. The title of my dissertation is "A Causal-Comparative Study of Beginning Teachers Self-Efficacy with Technology Integration" and the purpose of my research is to determine if there is a relationship between beginning teacher self-efficacy with technology and the level of technology infusion in their undergraduate programs.

I am writing to request your permission to use the Technology and Teaching Efficacy Scale (TTES) to collect data for my research this spring. Thank you for considering my request. If you choose to grant permission, please respond by email to rjohnson398@liberty.edu.

Sincerely,
Reeshemah Johnson
Doctoral Student
School of Education
Liberty University

APPENDIX C: Permission from School System to Administer Survey

[redacted]

Date: September 16, 2019

Reeshemah Johnson
Doctoral Candidate
Liberty University

From: [redacted]

Study: *A causal-comparative study of beginning teachers' self-efficacy with technology integration based on the level of technology infusion in the undergraduate teacher education program*

Dear Reeshemah Johnson:

After careful review of your research proposal entitled "A causal-comparative study of beginning teachers' self-efficacy with technology integration based on the level of technology infusion in the undergraduate teacher education program", the [redacted] Research Committee has decided to grant you permission to conduct your research. The Research Committee approved your request to conduct your study under the conditions that you comply with [redacted] ICC and Research Project Guidelines.

Any resources, surveys, or invitations should be emailed to me at [redacted] I will send the information to principals, who will share it with the appropriate staff members. Please keep in mind that participation is voluntary and instructional time is not to be interrupted.

Congratulations and best wishes with your research project.

Sincerely,

[redacted]

[redacted]

APPENDIX D: IRB Approval

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

October 3, 2019

Reeshemah Johnson
IRB Exemption 3987.100319: A Causal-Comparative Study of Beginning Teachers' Self-Efficacy with Technology Integration Based on the Level of Technology Infusion in the Undergraduate Teacher Education Program

Dear Reeshemah Johnson,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under exemption category 46.101(b)(2), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

> (2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
>
> > (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

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APPENDIX E: Recruitment Email Sent to Participants

March 31, 2020

Dear Beginning Teacher:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree. The purpose of my research is to determine if there is a relationship between the level of beginning teachers' confidence with integrating technology and the technology integration approach in their undergraduate degree programs. The results will help educator preparation programs determine the optimal approach for technology integration in their undergraduate programs. I am writing to invite you to participate in my study.

If you are a beginning teacher who graduated from a 4-year educator preparation program (School/College of Education) and are willing to participate, you will be asked to complete a brief survey. It should take approximately 10 minutes for you to complete the survey. Your participation will be completely anonymous, and no personal, identifying information will be collected. To participate, click on the link below.

An informed consent document is provided on the first page you will see after you click on the survey link. The consent document contains additional information about my research. Please click on the arrow at the end of the consent page to indicate that you have read the consent information and would like to participate in the survey.

If you choose to participate, you will be entered in a raffle/contest to receive **one of three $100 Visa gift cards**.

Sincerely,

Reeshemah Johnson
Doctoral Student
Liberty University School of Education

Take the survey!

APPENDIX F: Informed Consent Form

CONSENT FORM

A Causal-Comparative Study of Beginning Teachers' Self-Efficacy with Technology Integration Based on the Level of Technology Infusion in the Undergraduate Teacher Education Program

Reeshemah Johnson
Liberty University
School of Education

You are invited to be in a research study on the relationship between the level of beginning elementary school teachers' confidence with integrating technology and the technology integration approach in their undergraduate degree programs. You were selected as a possible participant because you are an elementary school teacher within the first three years of your career, and you graduated from a four-year school/college of education. Please read this form and ask any questions you may have before agreeing to be in the study.

Reeshemah Johnson, a doctoral candidate in School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to determine if there is a significant difference in technology integration self-efficacy scores among beginning elementary school teachers by level of technology infusion in their undergraduate program (dedicated technology course, technology infusion, or dedicated technology course plus technology infusion).

Procedures: If you agree to be in this study, I would ask you to complete and submit the technology integration survey. This will take approximately 10 minutes.

Risks: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Benefits: Participants should not expect to receive a direct benefit from taking part in this study. The results of the data will help inform the conversation on how to best prepare teachers to integrate technology in teaching and learning. This will help in the training of teachers who are comfortable with integrating technology, which will in turn benefit today's digital students. Students who are taught to use technology in an appropriate and responsible manner will become good digital citizens and will be able to contribute to an increasingly technological society.

Compensation: Participants may choose to enter a drawing for one of three $100 Visa gift cards. Gift cards will be sent to winners on May 15, 2020. Participants must complete the entire survey to be entered in the drawing for the gift cards. Email addresses will be requested for compensation purposes; however, they will be pulled and separated from your responses by Qualtrics, the survey platform, to maintain your anonymity.

Confidentiality: The records of this study will be kept private. Research records will be stored securely, and only the researcher will have access to the records. Data will be stored on a password locked computer and may be used in future presentations.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University or Cumberland County Schools. If you decide to participate, you are free to not answer any question or withdraw at any time prior to submitting the survey without affecting those relationships.

How to Withdraw from the Study: If you choose to withdraw from the study, please exit the survey and close your internet browser. Your responses will not be recorded or included in the study.

Contacts and Questions: The researcher conducting this study is Reeshemah Johnson. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at rpjohnson@liberty.edu. You may also contact the researcher's faculty chair, Dr. Meredith Park, at mjpark@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

APPENDIX G: Demographic Questions

Please respond to the following items:

1. What is your gender?

   ______Male

   ______ Female

2. What is your age?

   _______18 – 24

   _______25 – 34

   _______35 – 44

   _______45 – 54

   ______ 55 – 64

   _______65 – 74

   _______75 – 84

   _______85 or older

3. How many years have you been teaching?

   ______ Less than a year

   ______ 1 year

   ______ 2 years

   ______ 3 years

4. Did you graduate from a teacher education program in North Carolina?

   ______ Yes

   ______ No

6. How would you say your teacher education program prepared candidates to incorporate technology in the classroom?

   ______ My program included just a class dedicated to preparing candidates to integrate technology in the classroom.

   ______ My program DID NOT have a class dedicated to preparing candidates to integrate technology in the classroom, BUT instructors incorporated technology integration in the teacher education courses.

   ______ My program included a class dedicated to preparing candidates to integrate technology in the classroom, AND instructors incorporated technology integration in the teacher education courses.